

# SCIENCE

VOL. LXVII

APRIL 13, 1928

No. 1737

## CONTENTS

<i>The American Association for the Advancement of Science:</i>	
<i>Contributions of the Chemist to our Knowledge of Biological Oxidations:</i> DR. EDWARD C. KENDALL	379
<i>Contributions of Anthropology to Medicine:</i> DR. ALEŠ HRDLÍČKA	385
<i>Edward Sandford Burgess:</i> THEODORE E. HAMILTON	388
<i>Scientific Events:</i>	
<i>A New Edition of Willard Gibbs's Works; Barro Colorado Island Station; Appropriations of the General Education Board; Annual Meeting of the American Geophysical Union</i>	389
<i>Scientific Notes and News</i>	391
<i>University and Educational Notes</i>	394
<i>Discussion and Correspondence:</i>	
<i>The Aurora of March 28, 1928:</i> DR. H. T. STETSON. <i>The Washboard or "Corduroy" Effect in Dirt Roads:</i> RAY C. TREASHER, ELLWOOD WILSON. <i>Ovarian Secretion and Cancer:</i> WILLIAM S. MURRAY. <i>Relation of the Sun's Activity to some Biological Factors:</i> DR. G. I. POKROWSKI. <i>The Sharp Rattling in Steam Pipes:</i> PROFESSOR R. C. COLWELL. <i>Scientific Obscurity:</i> DR. EDWIN E. SLOSSON	394
<i>Scientific Books:</i>	
<i>Hoffmann's Birds of the Pacific States:</i> DR. TRACY I. STORER. <i>Rogers's Text-Book of Comparative Physiology:</i> PROFESSOR C. W. GREENE	398
<i>Scientific Apparatus and Laboratory Methods:</i>	
<i>The Collodion Method and Serial Sections:</i> DR. E. E. CAROTHERS	400
<i>Special Articles:</i>	
<i>Direct Evidence of Atom Building:</i> DR. R. A. MILLIKAN and DR. G. H. CAMERON. <i>Water Soluble Phosphorus in Soils:</i> DR. F. W. PARKER	401
<i>The American Philosophical Society</i>	403
<i>Science News</i>	x

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

## THE SCIENCE PRESS

New York City: Grand Central Terminal.  
Lancaster, Pa. Garrison, N. Y.  
Annual Subscription, \$6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

## CONTRIBUTIONS OF THE CHEMIST TO OUR KNOWLEDGE OF BIOLOGICAL OXIDATIONS<sup>1</sup>

THE contributions of the chemist to our knowledge of biological oxidations are today of such magnitude that they constitute a subdivision of biochemistry. A mere enumeration of the problems which have been solved would be of little purpose; on the other hand, to speak at length on a few interesting details would be evidence of lack of appreciation of the great contributions which have been made. I shall therefore try to point out the methods by which the various types of investigation have been carried out rather than give great detail concerning any one investigation.

### CALORIGENIC RELATIONSHIPS

The problem of the oxidation of foodstuffs may be considered from the standpoint of the three classes of compounds, carbohydrates, fats and proteins. The calorogenic relationships were placed on a firm basis when it was shown that the same amount of heat was produced whether glucose was burned in the body or in a bomb calorimeter. Studies in the complicated apparatus necessary for direct calorimetry have now given way to the analysis of expired air, and for most work all the essential data may be obtained by indirect calorimetry.

After it had been shown that 1 gm. of glucose, 1 gm. of fat and 1 gm. of protein furnish to the animal organism 4.2 calories, 9.46 calories and 4.3 calories, respectively, it was realized that all the essential data required to estimate the diet requirements of an animal organism were at hand. These data, however, furnished no information concerning the mechanism by which glucose, fats and proteins were burned in the animal organism.

### INTERMEDIARY METABOLISM

Despite the large amount of work carried out in the field of intermediary metabolism many important questions remain unanswered. Embden and Meyerhof have shown that glucose apparently is utilized through the decomposition of a hexose phosphate, and the work of Hill and Meyerhof is very suggestive that at least a portion of the lactic acid is burned to

<sup>1</sup> Presented as part of a symposium on "The Contributions of Other Sciences to Medicine" at the annual meeting of the American Association for the Advancement of Science, Nashville, December 28, 1927.

carbon dioxide and water. This detail of the combustion of glucose has not, however, been proved, and Lusk has placed an interrogation point after this portion of the Hill-Meyerhof theory. It is possible that other substances are burned in place of lactic acid.

There is also the question whether glucose can be burned by any mechanism in the animal organism other than through the course of phosphoric acid ester, lactic acid, carbon dioxide.

Thunberg has shown that succinic acid is readily attacked by enzymes in the muscle, and the significance of this observation in relation to the combustion of sugars, proteins and fats is not clear.

Other problems relating to the oxidation of glucose deal with the phenomenon of antiketogenesis. Is sugar necessary for the proper combustion of fat in the animal organism? Shaffer and coworkers and others have indicated that it is, and have suggested a stoichiometric relationship. On the other hand, it has been suggested that ketone bodies are formed when the quantity of fat utilized is raised above a certain level. If glucose is burned in preference to fat the addition of carbohydrate to the diet would relieve the ketogenesis, but by a different mechanism than that suggested by Shaffer.

Still another problem in the oxidation of glucose is the specific dynamic action of this material. Lusk has shown that a plethora of glucose produces an increased rate of utilization of this sugar, and Wood-yatt has shown that continuous injection of glucose results in an increased rate of the oxidation of this material.

The combustion of fats is still shrouded with mystery. The one most important fact in the oxidation of fat is the evidence concerning the point of attack in a fatty acid; this was shown by Knoop. A long chain of carbon atoms terminating in a carboxyl group can be burned in the animal organism by the successive breaking off of groups of two carbon atoms at a time, but the details of this decomposition and the fate of the two carbon atoms is still unknown. Meissl and Strohmer, Voit and Lehmann and Lusk have shown that glucose can be converted into fat and it seems probable that the combustion of fat can be utilized for the production of mechanical energy in the body, but no one has yet conclusively shown that fat can be converted into glucose. The problems to be answered in this field are closely bound up with the fatty-acid-containing substances of the body, such as lecithin, cephalin, fatty-acid esters of cholesterol and other substances, some of which are insoluble in water, and yet are absorbed through the intestine and transported in the blood.

The combustion of the proteins involves the added problem of the fate of the nitrogen-containing sub-

stances. Some of the amino acids in protein can be converted into sugar and are probably burned as glucose; some apparently can not be converted into glucose but follow a separate path. Knoop has suggested that ketone acids and ammonia can interact with the formation of amino acids through the aid of the sulphydryl group of glutathione which functions as a reducing agent.

The influence of proteins on cellular activity has been investigated for many years. Through the work of Voit, Rübner, Lusk and many others it has been shown that the administration of proteins and certain of the amino acids results not only in the combustion of these substances but also in an increased rate of oxidation of other metabolites. This occurs in the phlorizinized dog, even though the carbon content of the amino acid is quantitatively excreted as glucose. The specific dynamic action of proteins is one of the most interesting and important phases of oxidation in the animal organism.

Probably the most important problem in the oxidation of glucose, fats and proteins is the relationship of glucose to other carbon compounds. It is hoped that the investigation of intermediary metabolism will eventually explain the conversion of glucose-forming substances to sugar and bring into harmony the theories concerning the utilization of carbohydrates, fats and proteins for the production of heat and energy.

#### FOOD ACCESSORIES

After it had been shown that a diet should contain carbohydrate, fat and protein, it was assumed that any normal animal organism would grow to maturity and enjoy normal health provided a sufficient number of calories of a well-balanced diet was furnished. The satisfied feeling which accompanied this conclusion was rudely jarred about fifteen years ago by the discovery of a group of substances which were termed food accessories, or vitamins, that appeared to be essential for the proper growth and maintenance of health in the normal animal organism.

This problem is with us to-day and one receives at least an introduction to these substances through the columns of the daily newspaper or the popular weeklies. I shall not discuss in detail the influence of the vitamins on the oxidation in the animal organism, but shall call attention to three substances which appear to be related, at least in their action, to the so-called food accessories.

Throughout the period during which biological oxidations have been investigated each successive decade has given its own peculiar contribution to the problem, and the investigators who have taken up this work in turn have doubtless felt that until some un-

suspected door was opened, further progress with the problem would be but meager.

The physicist of 1895 could not visualize the magnitude of the regeneration which would follow the discovery of radioactivity and the better understanding of electromagnetic vibrations. The biochemist in 1895 did not realize that he would soon look down a long avenue through a door which had just been opened to permit a partial view of the problems and triumphs which were to come.

During the few years preceding 1895, the attention of clinicians was strongly attracted to the striking results obtained by feeding the thyroid gland to human beings and experimental animals deficient in thyroid function, and in December of that year Baumann published the important discovery that iodine was a normal constituent of the thyroid gland. Because of the clinical importance of this work it was soon followed by a more detailed investigation and in a relatively short time Magnus-Levy showed that administration of the thyroid gland increased the rate of oxidative processes in the body. I shall not at this time outline the isolation of thyroxine and the subsequent developments in this field.

About twenty-five years ago through the efforts of Abel, Takamine, Aldrich, Lucius, Brüning and Flächer, the first crystalline compound from a gland of internal secretion was isolated, identified and synthesized and it was soon shown that epinephrin or adrenaline affected physiological processes to a marked degree. Many years passed, however, before Boothby, Marine, Means, Soskin and others showed that in this case also at least a portion of the effect is due to a change in the rate of oxidation.

Through the efforts of still a third group of investigators, Hottinger, Thunberg, Meyerhof, Hopkins, Dixon, Tunnicliffe, Voegtlin and others, another agent of great significance in biological oxidations was recognized and finally isolated, identified and synthesized, glutathione.

The isolation and identification of these compounds, however, did not mark the completion of the problem. The chemical properties and effects of these three compounds and related substances will occupy the attention of investigators for many years.

The first step necessary was to determine the end results brought about by the administration of these compounds. Careful determinations of the basal metabolic rate and of the intake and output of nitrogen, sulfur, calcium, etc., have been made and quantitative relationships have been determined concerning the effect of thyroxine.

The influence of adrenaline on blood sugar, carbon dioxide output and oxygen consumption has been shown, and the influence of glutathione on oxidation

in vitro and on muscle tone has been studied. These results deal only with the end products of reactions which are irreversible within the animal organism. It was recognized that energy had been generated by a combination of the oxygen of the air with hydrogen and carbon of the food, but the mechanism by which thyroxine, adrenaline or glutathione brought about a change in the velocity of oxidative processes has remained up to the present time an unsolved problem.

The problem is complex and must be approached through the efforts of investigators from many different points of view. The processes influenced by these agents take place in a colloidal medium where surface tension, phenomena of adsorption, the selective action dependent on stereoisomerism—and the commanding influence of hydrogen-ion concentration affect the mechanism involved. The equilibrium which exists is delicately balanced.

It is obvious that the tissues can not be in a state of static equilibrium. Even at rest chemical processes are continually occurring and the problem involves a kinetic equilibrium which is influenced by innumerable factors.

#### OXIDATION-REDUCTION POTENTIALS

Before the work of van't Hoff, Arrhenius, Ostwald, Sorenson, Clark and others the relations between amphoteric substances and hydrogen-ion concentration in biological phenomena were not appreciated. The early workers in the field of biological oxidations were not cognizant of the static and kinetic equilibria which exist between oxidizing and reducing agents and the velocity of the reactions associated with life processes. By the use of oxidizing dyes many qualitative results were obtained and attempts were made to determine the intensity of oxidation in the animal organism, but the actual progress made toward this objective was but meager until still another avenue of approach for a quantitative study of the oxidation-reduction intensity was opened by Clark and co-workers.

This group of investigators has made a great contribution to our knowledge of oxidation-reduction potentials, and now for the first time the investigator in oxidation-reduction processes is equipped not only with an adequate theory concerning the mechanism involved but furthermore with a series of dyes which have been studied with precision so that the intensity of oxidation of any given solution can be determined within narrow limits.

This painstaking investigation has opened for the biochemist of 1927 a wide entrance to a fertile field; before the end is reached biological oxidation will be intimately linked with simpler systems by means of a fuller understanding of the physico-chemical prin-

ciples involved. The processes occurring in the tissues, which are described to-day as enzyme action, will be explained in terms of thermodynamics to a degree which has been up to the present wholly unattainable.

The problem of biological oxidation was presented by Hopkins in 1926 at the International Congress of Physiologists. He reviewed the two theories: activation of oxygen suggested by Warburg and others, and primary dehydrogenation suggested by Wieland and others. The dehydrogenation theory of Wieland was favored by the essayist, although it was evident that probably a middle ground would eventually afford the correct interpretation of the phenomena.

Clark has shown that the intensity of oxidation or reduction of organic dyes is related to the structure of the dye and he has proposed a theory of the mechanism of oxidation-reduction processes which is broad enough to include the essential features of both those of Wieland and of Warburg. This theory expresses the oxidation and reduction of complex organic dyes in the same terms employed to describe the reaction involved in the oxidation or reduction of inorganic compounds such as ferrous and ferric salts. In the words of Clark:

Oxidation may be regarded as the withdrawal of electrons from a substance with or without the addition of oxygen or elements analogous to oxygen or as a withdrawal of electrons with or without the withdrawal of hydrogen or elements analogous to hydrogen. Reduction is the reverse of oxidation as defined above.

This definition meets on common ground with the definition of an acid and a base given by Lewis:

A basic substance is one which has a lone pair of electrons which may be used to complete the stable group of another atom, and that an acid substance is one which can employ a lone pair from another molecule in completing the stable group of one of its own atoms. In other words, the basic substance furnishes a pair of electrons for a chemical bond, the acid substance accepts such a pair.

When the phenomena of biological oxidation are investigated with this broad viewpoint, both in respect to the nature of oxidizing and reducing substances as well as acid and basic compounds, the nomenclature and the significance of the chemical reactions involved form a continuous pathway from the complex field of biological oxidation through to the realm of simple water solutions containing only inorganic substances. Such a theory has proved adequate up to the present and, by excluding the question of whether or not hydrogen is added or removed during the processes of oxidation and reduction, has eliminated an unnecessary and superfluous detail.

To insist upon the addition or removal of hydrogen but complicates the problem. Clark has pointed out that because hydrogen is associated with a reductant when removed from solution is not evidence that the hydrogen is actually a component part of the compound as it exists in solution. However, the theory that the reactions are dependent on the transfer of electrons from those substances which can furnish electrons, or the acceptance of electrons by compounds that can accept them furnishes a viewpoint which will satisfy the broadest requirements of the problem, at least for many years.

#### OXIDATION CHARACTERISTICS OF ADRENALINE AND ITS DERIVATIVES

The beautiful experiments of Gesell on control of respiration have been made possible by the development of methods for the determination of the relationship between oxygen, the oxidative rate in the tissues and the hydrogen-ion concentration in the living animal organism. Means has also reported the effect on the circulation of changes in the basal metabolic rate due to the administration of thyroxine and adrenaline. An investigation has been carried out in my laboratory, with E. J. Witzemann, which carries our knowledge of the chemical reaction involved back one step further and has brought to light some chemical characteristics of adrenaline and glutathione which have been demonstrated in simple buffer solutions.

Throughout this work it was assumed that the surface of the platinum electrode indicated the concentration of electrons from the substances in the solution which could be regarded as reducing agents, and that the oxidation-reduction potential indicated by the platinum was the algebraic sum of the influence of available electrons and the effect of the total oxidant in the solution. The compounds related to adrenaline can be divided into three groups: (1) ephedrin, (2) adrenalone, and amino and dimethyl-aminoacetopyrocatechol, (3) adrenaline, the methyl and ethyl ethers of adrenaline and the anhydride of adrenaline.

The first problem investigated was whether these substances can be reversibly oxidized. It was quantitatively shown that ephedrin could be neither oxidized nor reduced at a pH 7.4 with any of the oxidizing dyes used, with or without the presence of molecular oxygen or hydrogen peroxide. Adrenalone and its two derivatives act as reducing agents toward dibromophenolindophenol and indigo carmine and can be reversibly oxidized; adrenaline and its three ether derivatives are all oxidized by dibromophenolindophenol, but are not oxidized by indigo carmine. However, when the compounds in Group 3 are

oxidized, the molecule is so altered that the solution does not contain any oxidizing substances. The end products of mild oxidation of adrenaline, therefore, may be described as irreversible.

The results of this part of the investigation have established certain characteristics of these substances which are of the greatest significance: first: the velocity of oxidation and the degree of oxidation are not determined by the intensity of the oxidizing agent used; and, second, before adrenalone and its derivatives can act as reducing agents some intermediate addition complex must be formed which activates the compound and permits it to function as a reducing agent.

The first conclusion is clearly shown by the velocity of oxidation of adrenalone and its derivatives with dibromophenolindophenol, methylene blue and indigo carmine. Indigo carmine has an almost specific effect on the molecule and the presence of 5 per cent. of one equivalent of indigo carmine markedly increases the velocity of oxidation with dibromophenolindophenol. Such a result is contrary to the usual velocity of oxidation induced by these dyes.

When molecular oxygen is passed through a solution of adrenalone dissolved in phosphate buffer, pH 7.4, no oxidation of the adrenalone occurs. If, as assumed by Wieland, hydrogen is first removed from the molecule then adrenalone can not spontaneously act as a hydrogen donor in the presence of molecular oxygen, or in the terms of Clark we can conclude that electrons can not be withdrawn from the adrenalone molecular with molecular oxygen. The same stability of the molecule is exhibited toward hydrogen peroxide. Furthermore, adrenalone does not appreciably affect the platinum electrode, which indicates that adrenalone can not affect the concentration of electrons in a solution at pH 7.4. However, if to such a solution 5 per cent of one equivalent of indigo carmine is added, the dye is rapidly reduced, and the platinum electrode indicates a marked reduction potential. If, as well as the indigo carmine, molecular oxygen or hydrogen peroxide is added there is a cyclic oxidation and reduction of the indigo carmine resulting in the oxidation of the adrenalone. This effect of adrenalone is evidence for the second characteristic which I have attributed to this substance and can be explained on the assumption that some type of addition compound is formed between indigo carmine and adrenalone: the result of this reaction is the liberation of available electrons.

Two other observations were made: (1) Indigo carmine is reduced by adrenalone even in the presence of an excess of hydrogen peroxide. Hydrogen peroxide added to a solution of reduced indigo carmine results in the rapid oxidation of the dye, but in the

presence of adrenalone oxidation of the reduced indigo carmine occurs but slowly.

(2) The formation of some addition complex between adrenalone and the oxidizing dye is indicated by the addition to the solution of a compound which does not have oxidation-reduction power itself, but which inhibits the oxidation of adrenalone by the oxidizing dye. Such a substance is tungstic acid. If but a small percentage of one equivalent of tungstic acid is added to a solution of adrenalone in phosphate buffer, pH 7.4, there is no change in hydrogen-ion concentration, but the velocity of oxidation with dibromophenolindophenol or with indigo carmine is reduced almost to zero. It can not be assumed that the amount of tungstic acid in the solution caused an oxidation of the reduced form of the dye, and the reaction is adequately explained by the assumption that the formation of an addition complex between adrenalone and the dye is prevented by the presence of the small amount of tungstic acid. No precipitate is formed in the solution.

The effect of oxidizing dyes on adrenalone is similar to the effects of oxidizing dyes on other biological products. As Oppenheimer points out, nothing occurs in these cases except that the hydrogen is taken up by the acceptor and then the leuco dye formed turns it over to the oxygen. He concludes by saying, "This is the fact, the explanation is not available."

The results which I have outlined indicate that actual addition products are formed in the solution.

The necessity for a consideration of the chemical configuration of an oxidizing dye is strikingly shown by the influence of dibromophenolindophenol, methylene blue and indigo carmine on dimethylaminoacetopyrocatechol. This compound reacts sluggishly with dibromophenolindophenol, but if indigo carmine is added to the solution the velocity of oxidation is markedly increased. The discrepancy reaches its maximal proportions when methylene blue is used. This dye is not reduced by dimethylaminoacetopyrocatechol, but if a small percentage of one equivalent of indigo carmine is added to the solution prompt reduction of both dyes occurs. This is evidence that the formation of an addition complex is essential for the interaction of this group of compounds with oxidizing dyes.

If addition complexes between adrenalone and metabolites can be formed in the animal organism, it is possible that this reaction explains in part the marked effect of this series of compounds on the oxidative process in the animal organism. It therefore became desirable to show that a similar reaction occurs with adrenaline. Toward oxidizing dyes adrenalone reacts in a manner closely simulating that of

adrenalone, except that it is entirely stable toward indigo carmine.

Experiments showed, however, that adrenaline does not function as an oxidizing agent after it has been partially oxidized with a dye. This was eventually shown to be due to the fact that one portion of the adrenaline molecule is too unstable to remain unaffected by the oxidized portion of the molecule. The result of the interaction of the two portions of the adrenaline molecule is the loss of all oxidizing power which can be transferred subsequently to another substance. This suggested the possibility of demonstrating the cyclic oxidation and reduction of adrenaline, provided some substance was present which would reduce oxidized adrenaline before one portion of the adrenaline molecule reacted with the oxidizing group. Adrenalone will serve this purpose. If air is passed through a solution of adrenaline the adrenaline is oxidized. If air is passed through a solution of adrenalone there is no effect. If air is passed through a solution of adrenalone containing a small amount of adrenaline the adrenalone is oxidized and then, and only then, will the molecular oxygen destroy the adrenaline. The presence of adrenalone, therefore, prevents the adrenaline molecule from reacting with itself, and the net result of the reaction is the oxidation of adrenalone.

This reaction, however, is not quite so simple. It will occur provided a fourth compound is present in the solution, but the presence of such a substance is essential. Such a compound is present in a solution of glucose which has been oxidized with molecular oxygen in the presence of alkali and indigo. The chemical groups which are necessary are unknown, but, in the presence of this compound, molecular oxygen will oxidize adrenalone provided adrenaline is also present. The results are quantitative and striking, and emphasize the necessity for the presence of these four substances before this reaction can take place.

This indicates the delicately balanced equilibrium which must be present, and further indicates the necessity of the formation of addition products before oxidation can occur.

#### OXIDATION-REDUCTION POTENTIALS OF GLUTATHIONE

Still further evidence concerning the formation of addition complexes has been secured by Nord in the oxidation of glutathione. In the absence of oxygen or sulfur, glutathione and cysteine can not reduce indigo carmine; if, however, oxygen is admitted to a solution containing cysteine and indigo carmine or if a small percentage of one equivalent of sodium disulfide is added to such a solution, prompt reduction of the indigo carmine occurs; moreover, the solution is

capable of reducing further additions of indigo carmine.

If such a solution is boiled the cysteine or glutathione present can no longer reduce indigo carmine, and finally the actual oxidation-reduction intensity of the solution is determined by the ratio of  $-SH$  to the  $-SS$  groups which are present in the solution. These results are explained by the formation in the solution of thermolabile oxygen or sulfur addition products between indigo carmine and cysteine which activate both the  $-SH$  and  $-SS$  groupings.

These results indicate that the  $-SS$  grouping is capable of exerting an oxidizing influence, and, although such power of the  $-SS$  grouping is absent in a simple phosphate buffer solution, in the presence of the oxygen addition product the  $-SS$  grouping of cysteine or oxidized glutathione will oxidize reduced indigo or reduced indigo carmine.

The demonstration that the activity of glutathione is dependent on the presence of thermolabile unstable addition products containing oxygen and sulfur suggests that the biological significance of these compounds depends upon the presence of similar substances in the animal organism. Investigation of the activity of the  $-SH$  and  $-SS$  forms of glutathione in vivo has shown that the condition in which these substances exist depends on the metabolic changes occurring in the muscles, liver and kidneys.

The potentiometric investigation of the activity of these compounds furnishes a glimpse of that complex, ever-changing series of reactions which is occurring in vivo and upon which physiological processes are dependent.

#### NECESSITY FOR ACTIVATION

The determination of the oxidation-reduction potentials of the derivatives of adrenaline is conclusive evidence that these substances are not of themselves powerful reducing or oxidizing agents and that they must be activated by other substances in the tissues of the animal organism before they can influence the intensity of the oxidation-reduction processes involved.

Dixon has suggested that the  $-SH$  group of cysteine dissociates even in a simple phosphate buffer with the liberation of hydrogen and the formation of cystine. The results reported in this communication indicate that before the  $-SH$  group can function as a reducing agent with sufficient intensity to reduce indigo carmine the sulphydryl grouping must be activated by the presence of some type of oxygen addition product.

These results emphasize the importance, in biological processes of oxidation, of addition complexes which appear to be essential for the functioning of at least adrenaline and glutathione. The activating

influence of oxygen or its chemical equivalent has not been appreciated, largely because the experimental methods employed have not adequately excluded oxygen from the sphere of reaction. With properly controlled experimental technic it can be shown that oxygen occupies a unique position concerning the oxidation-reduction power of cysteine and glutathione. This action is not concerned with the oxidizing power of oxygen but with the activation of the sulfur atom in the presence of thermolabile oxygen addition products so that the -SS and -SH groups can manifest their latent powers of oxidation and reduction.

EDWARD C. KENDALL

MAYO FOUNDATION

### CONTRIBUTIONS OF ANTHROPOLOGY TO MEDICINE<sup>1</sup>

IN the first number of the *American Journal of Physical Anthropology* for this year, I had occasion to point out the intimate and direct relations of anthropology with medicine and to show, briefly, what medical men, more particularly the anatomists, have done for anthropology. On the present occasion I want to call attention, equally briefly, to what anthropology has done for medicine.

The subject will, I think, be at once clearer and more sympathetic to you when I remind you that anthropology, in a large measure, is merely the daughter and a continuation of the medical sciences. The best and briefest definition of physical anthropology that we are able to arrive at to-day is that it is the human *phylogeny* of the past, the present and the future. More in detail it is, first, the science of human origin and evolution, or of human phylogeny; second, it is the comparative science of the human life cycle from its inception to its end or human ontogeny; and third, it is the science of human variation. All of which means merely that it is human biology, and advanced, comparative, human anatomy, physiology, chemistry and even pathology.

The distinctive feature of anthropology and the one that separates it most from the regular medical sciences is its *comparative* nature. It deals not with the characters and manifestations of an abstract or average human being, as do the medical branches, but studies human groups, whether they be age, sex, racial, social, occupational or even abnormal groups, comparing them with others. As to "practical" application there is the difference that medicine tries essentially to restore the damaged or diseased goods,

<sup>1</sup> Presented as part of a symposium on "The Contributions of Other Sciences to Medicine" at the annual meeting of the American Association for the Advancement of Science, Nashville, December 28, 1927.

while anthropology endeavors to find and to show the harmful as well as the favorable means for further human evolution. Anthropology, with much justice, could be called the medicine of human groups.

Being what it is, it must be quite plain to all of us that indirectly or directly the bulk of the research in physical anthropology is of more or less value to medicine. That medicine does not or can not as yet make fuller use of anthropological knowledge is quite another matter, related to its similar inabilities in respect to biology, physics and even chemistry; it is the difficulty of assimilation. It may be said at once, however, that medicine is already using many results of anthropological research without being always conscious of the source.

Let us approach the concrete facts. Research in physical anthropology began materially in the fifties of the last century. The register of printed anthropological articles and books since then reaches many thousands.

Taking the card catalogue of these publications in my division, I find that over 50 per cent. of the titles are direct contributions to comparative human anatomy, physiology or pathology. A few examples may elucidate this further. Let us take, quite at random, the three items of "skull," child" and "pelvis," and see the nature of the anthropological studies under these heads:

Skull	Children	Pelvis
Anomalies	Abnormalities	Age changes
Architecture	Backward	Anomalies and
Asymmetries	Births, multiple,	abnormalities
Capacity	etc.	Anthropological
Capacity vs. stature in defectives	Brains of defective	differences
Deformations	Development	Deformations
Development and growth of distinguished men and women	Dimensions	Dimensions
Evolution	Infanticide	Evolution in fetus and child
	Pathology, comparative	Ossification
	Pulse, respiration, temperature	Sexual characters
		Variation

Practically every more civilized country has already one or more periodicals devoted largely or entirely to physical anthropology. Let us take the first page or two of the index of the oldest of these journals, the *Bulletin* of the Anthropological Society in Paris, and we find such items as these:

Abdomen: (racial differences in the muscles of);	Agraphy;
Acclimatization;	Albinism;
Accouchement (childbirth), among different peoples;	Alcoholism, and depopulation, criminals, suicides;
Achondroplasia;	Algiers—demography, psychology;
Acrocephaly;	Alienation, mental, and the brain, etc.
Aeromegaly;	

A still better illustration, perhaps, may be furnished by our own journal of physical anthropology (*The American Journal of Physical Anthropology*, Wistar Institute) which I had the privilege of founding in 1918. Taking the more formal communications alone, we have the following record for the first ten volumes:

Human Evolution Early man Origin of races	Embryology Childhood and Adolescence Senility Elimination General body proportions	Human Variations; Racial; Individual parts and organs (External parts, internal or- gans, brain, skeleton, etc.) Teeth	Heredity Eugenics Demography Abnormal Classes	Comparative hu- man physiol- ogy Chemistry Pathology Teratology Primitive sur- gery	The character- istics, morpho- logical, physi- ological, etc., of the people of the U. S. A.	General, Historical, Methods, Instruments.
(23)	(20)	(75)	(6)	(19)	(6)	(23)
Per cent.						
13.4	11.6	43.6	3.5	11	3.5	13.4
						Total: 172

Another illustration, and one of some interest also to the chemists, may be had by reading the titles of papers published in the first three numbers of the journal just named, of the current year. They are:

- Hrdlička (Aleš): Anthropology and Medicine.  
 Manoilloff (E. O.): Discernment of Human Races by Blood.  
 Poliakowa (Anna T.): Manoilloff's "Race" Reaction and its Application to the Determination of Paternity.  
 Suk (V.): Anthropological and Physiological Observations on the Negroes of Natal and Zululand.  
 Davenport (C. B.): Measurement of Men.  
 Connolly (C. J.): Relation of the Orbital Plane to Position of Teeth.  
 Hirsch (N. D. M.): Cephalic Index of American-born Children of Three Foreign Groups.  
 Cummins (Harold) and Midlo (Charles): Dermatoglyphics in Jews.  
 McMurich (J. Playfair): The Evolution of the Human Foot.  
 Morton (D. J.): Human Origin.  
 Hrdlička (Aleš): Anthropology of the American Negro.  
 Appleton (Vivia B.): Growth of Chinese Children in Hawaii and in China.  
 Larsen (Nils Paul) and Godfrey (Lois Stewart): Sacral Pigment Spots.  
 Cameron (John): Cranial Studies.  
 Ingalls (N. W.): Studies on the Femur.  
 Manoilloff (E. O.): Blood: Species Reaction.  
 Seammon (R. E.): The First Seriatum Study of Human Growth.  
 Dodge (C. T. J.): Weight of Colored Infants.  
 Hrdlička (Aleš): Quadruped Progression in the Human Child.

Bushkovitch (V. J.): An Automatic Apparatus for the Measurements of Cranial Capacity.

Slome (D.): The Curvature of the Bushman Calvarium.

Bernstein (Morris) and Robertson (Sylvan): Racial and Sexual Differences in Hair Weight.

Cady (Lee D.) and Francis (Byron F.): The Supracondyloid Process in the Feeble-minded.

Ingalls (N. W.): Studies on the Femur in the White and the Negro.

Among the more noteworthy individual contributions of anthropology to medicine may be mentioned—to select only a few of the older names—those of Paul Broca and Gustaf Retzius on the brain; of Manouvrier on brain physiology; of Rudolf Virchow on deformities of the skull; of Quetelet and Vierordt on human proportions; of Galton, Lombroso on human heredity, on men of genius and on the defective classes; those of Sir Armand Ruffer on prehistoric pathology, etc., etc.

Taking the older American anthropologists,<sup>1</sup> we see Samuel D. Morton, as early as 1850, contributing on "the size of the brain in various races and families of man"; Joseph Leidy, in his anthropological work, contributes on acephaly; blood crystals; causes of monstrosities; senile changes in the jaw; reversed viscera in man, and the anomalies of the human skull. J. C. Nott, in 1857, writes on "Acclimatization," or the comparative influence of climate and disease on the races of man; Jeffries Wyman, in 1849, publishes "Twelve Lectures on Comparative Physiology"; in 1854-1862, "Dissections of a Human Fetus, a Chimpanzee, a Hottentot"; in 1864-68, on "Symmetry and Homology in Limbs," and on "Malformations." Henry P. Bowditch, beginning to publish in 1877, gives us valuable papers and memoirs on the growth of children; relations between growth and disease,

<sup>1</sup> See full bibliographies in Hrdlička, A., "Physical Anthropology: Its Scope and Aims; its History and Present Status in the U. S. A." 8°, 1919 (Wistar Inst., Phila.).

and the physique of women in Massachusetts. Harrison Allen publishes (1867-97) on the effect of the bipedal position in man; the Siamese twins (autopsy); edentulous jaws in man; congenital defects of the face; hyperostosis of lower jaw; effects of cretinism on the nasal chambers, and the effects of senility and disease on the teeth. Thomas Dwight, Burt G. Wilder, Dudley A. Sargent, the two Spitzkas, A. F. Chamberlin, Geo. S. Huntington, F. P. Mall left us studies of value on the spine, the appendix and viscera, the brain, the embryo, the child, the college boy and girl. And this by no means exhausts the lists.

Coming to the still living American anthropologists, we find Bean contributing to our knowledge of the weight and size of the internal organs, in health and disease, and to the relation of man's build to pathology. Boas has dealt with growth of children, effects of hybridism and race mentality. Davenport deals with human heredity and the defectives. Hooton has published, among other works, on herbivorous and carnivorous types of man; on the evolution of the human face, and on surgery in ancient Egypt. Terry and his associates, and Danforth, are contributing to our knowledge of the human hair, bone variation, anomalies, and human variation in general. Todd and his students have published on age changes in human bones (pelvis, scapula), on the femur, on structural differences between the white and negro. The anthropologists of the Smithsonian Institution have or are still carrying on researches on prehistoric trephining; on physiological and medical observations on the Indians; on tuberculosis in the Indians; on brain weight, brain preservation, racial brains; on the dental arches and teeth; on the physical and physiological characteristics of the adult white Americans; on ear tumors and other ear abnormalities in prehistoric Indians, etc., etc.

Taking all this impersonally and from a wider angle, we see that anthropology has given medicine, and is now giving, three lines of contributions of both weight and value. The first of these is the ever-growing light on human evolution, and that both in the past and at the present; the second comprises the results of our studies on human variation; and the third is the furnishing to medicine of normal standards.

A knowledge of human evolution, past, present and with indications for the future, is indispensable to medicine if this is to fathom the deeper causes, and the trends, of a large part of human pathology, with its differences according to race and type and group.

Equally indispensable to scientific medicine of the future will be a sound knowledge of human variation. For this teaches that even under the most "normal" or uncomplicated conditions, everything, in our frame,

organs, functions, and even the causes of disease, and the process of the same, is subject to an important range of variation. The medical text-books, your anatomies, physiologies and pathologies, deal not with the realities as they are, but with "workable" abstracts or gists of these realities. Yet without the understanding of the normal variation of every feature, every process, every manifestation of man, normal and abnormal, a true understanding of any part of medicine is not possible.

Here anthropology has been and continues to be a veritable handmaid of medicine. It shows that, for example, the normal weight of the child, at any age, is not just *that*, but between so much and so much. The normal stature of an adult American male is not 5 feet 7½ inches, but anywhere between, say, 5 feet 4 inches and 6 feet 3 inches. The normal male pulse is not invariably 71.5, but ranges between 66 and 78 per minute. The normal pelvis, head, any part or organ may show as much as 10 to 16 per cent. normal variation in size, with a considerable variation in form. The "normal" course of lobar pneumonia or any other affection is not "just so," but will oscillate between such and such limits.

The third main service of anthropology to medicine, the determination of standards, is connected with the preceding. It is self-evident that the medical man to judge properly must have normal standards of the parts in which he is interested at the time, in the particular people with whom he is dealing. And to find these standards (or averages), with their range of normal (non-pathological) variation, is the peculiar function of anthropological endeavor. A concrete example of this may be found in the recently published work, the "Old Americans,"<sup>2</sup> which brings such data on the principal morphological or physiological characters of the older white American population.

The value of anthropology to medicine is much better appreciated in the Old World, and even in such countries as Japan and China, than it is as yet in this country. There is not a first-class medical school abroad in which anthropology would not have more or less of a part. One of the best examples of this is Great Britain. In our own country, more or less anthropological instruction is given in the medical schools of Johns Hopkins, Harvard, University of Virginia, Western Reserve, Washington University (St. Louis), the University of Chicago and Stanford; the only regular course with a special lecturer in the subject (Professor A. Schultz) being that of the Johns Hopkins.

Many of our medical colleges and graduates, regretably, do not as yet know sufficiently of this source of

<sup>2</sup> Large 8°, 1926, Williams and Wilkins, Baltimore, Md.

helpful knowledge. Our anthropological journals have less subscribers and readers among the medical men, even the medical teachers, than they have among, for instance, the dentists, and the vast collections of both normal and pathological material in our osteological, brain and other collections are not used nearly so much as they should be by the medical man and the surgeon. All of which is due essentially to a lack of mutual contact and understanding. An improvement in these conditions is not merely desirable but necessary, and the anthropologist therefore welcomes the occasion of this symposium where he may point out some at least of the advantages of medicine and anthropology getting closer together.

ALEŠ HRDLÍČKA

U. S. NATIONAL MUSEUM

### EDWARD SANDFORD BURGESS

DR. EDWARD SANDFORD BURGESS, for thirty years professor and head of the department of biological sciences and for a time acting president of Hunter College, New York City, died after a brief illness on February twenty-third. He was born in 1855 at Little Valley, New York. His father, the Reverend Chalon Burgess, D.D., was long the pastor of the Presbyterian church at Silver Creek and was one of the most scholarly of the clergymen of western New York. His mother was Emma Johnston, daughter of the Reverend Charles Johnston, of Ovid, Seneca County.

Professor Burgess graduated from the State Normal School at Fredonia and later in 1879 with high distinction from Hamilton College. For two years he held a graduate fellowship in Greek, under the eminent scholar, Professor Gildersleeve, at Johns Hopkins. But because of his ardent love of nature and his habit from early boyhood of scientific observation, he decided to make the teaching of science his life work. In 1899 he received the degree of doctor of philosophy at Columbia University. Hamilton College, wishing to honor him for his distinguished work as a teacher and his contributions to scientific research, conferred upon him, in 1904, the degree of doctor of science.

He was for thirteen years professor of botany in the Central High School of Washington, D. C., and, during the same period, at the Martha's Vineyard Summer Institute. He taught also at Johns Hopkins (1885) University. In 1895 he was called to the professorship in biological sciences at Hunter College. His special spheres of labor were: (1) Botany, especially in asters; (2) botanical names, Indian names; (3) paleontology, anthropology, evidences of human descent.

Among his published works are the Chautauqua Flora (1877); botanical descriptions in the Century dictionary; the asters of the northern United States (in Britton and Brown's "Illustrated Flora"—with Dr. N. L. Britton (1898)); the asters of the southern United States (in Small's Southeastern Flora (1903)); history of Pre-Clusian botany (1902); species and variations of biotian asters (1906); essays on Indian lore, and poems. His unpublished manuscripts include a work on anthropology and research material in several fields.

Dr. Burgess was a member of Phi Beta Kappa; the American Association for the Advancement of Science; the New York Academy of Sciences; the Torrey Botanical Club, of which he was at one time the president; American Anthropological Society and American Folklore Society.

Professor Burgess is survived by Mrs. Burgess and his sister, Miss Julia Burgess, professor of English in the University of Oregon. His brother, Dr. Theodore C. Burgess, was for many years professor of Latin and Greek at the State Normal School at Fredonia and later the president of Bradley Institute, Peoria, Illinois.

At the time of his retirement from the professorship the following tribute was offered to him:

#### A TRIBUTE

IN GRATEFUL RECOGNITION OF THIRTY YEARS OF DISTINGUISHED SERVICE TO SCIENCE, TO THE CAUSE OF HIGHER EDUCATION, AND IN PARTICULAR TO HUNTER COLLEGE, NEW YORK CITY, AND TO THE THOUSANDS OF YOUNG WOMEN WHO HAVE STUDIED THERE, THIS TRIBUTE IS OFFERED TO

#### DOCTOR EDWARD SANDFORD BURGESS

PROFESSOR AND HEAD OF THE DEPARTMENT OF BIOLOGY  
AND SOME TIME ACTING PRESIDENT.

AN ORGANIZER AND EXECUTIVE OF MARKED ABILITY, A GIFTED AND INSPIRING TEACHER, A MODEL OF DEVOTION TO DUTY, A MASTER OF HIS SUBJECT AND A THOROUGH SCHOLAR IN MANY OTHER FIELDS, A MAN INSPIRED BY THE HIGHEST IDEALS AND RESPONSIVE TO ALL THE FINER AND NOBLER THINGS OF LIFE, BELOVED AND ADMIRER BY HIS PUPILS AND ASSOCIATES, HIS SERVICES CAN NOT BE MEASURED, FOR THEY HAVE BECOME A PART OF THE LIVES OF ALL WHO KNOW HIM. HE HAS GIVEN OF HIS BEST, AND A BEST FAR ABOVE THE AVERAGE, AND HE ALSO RECEIVES OF THE BEST—THE CONSCIOUSNESS OF HIGH SERVICE NOBLY DONE. COULD ALL THOSE WHO HAVE BEEN MADE BETTER BY HIS PRESENCE, INFLUENCE, AND EXAMPLE GIVE ADEQUATE EXPRESSION TO THEIR APPRECIATION, IT WOULD BE AS A FADELESS GARLAND IN WHICH THE LAUREL OF VICTORY IS ENTWINED WITH THE ROSES OF LOVE.

THEODORE E. HAMILTON

## SCIENTIFIC EVENTS

A NEW EDITION OF WILLARD GIBBS'S  
WORKS AND PROPOSED  
COMMENTARY

IN 1906 the writings of Willard Gibbs were printed in a collected edition of two volumes entitled, "The Scientific Papers of J. Willard Gibbs." Volume I contained all his papers on thermodynamics, and volume II the remainder of his published writings, with the exception of the book "Elementary Principles in Statistical Mechanics," which had been published only five years earlier and was at that time still available. At the present time both volume I of the "Scientific Papers" and the volume on "Statistical Mechanics" are out of print.

In connection with a movement started last winter to establish at Yale University a memorial in honor of Willard Gibbs, provision has been made, through the generosity of a donor who prefers to remain anonymous, for a new and complete edition of Willard Gibbs's writings. This will consist of either two or three volumes, well printed and bound, and will be sold at a very moderate price to encourage a wide distribution. It will probably be published during 1928.

In addition to this reprinting of the original text of Gibbs's works, it is proposed to publish, at some later date, a volume or volumes designed to aid the reader to bridge the well-recognized gap between Gibbs's theorems on the one hand and the actual experimental data of the chemist and physicist on the other. This supplementary material, to be written by competent authorities in the several fields, would aim (a) to explain the philosophical background of Gibbs's method; (b) to amplify the treatment of points of special difficulty; (c) to discuss the evaluation of Gibbs's functions in terms of directly measurable quantities, and (d) to furnish a variety of illustrative examples from the literature now available. Such treatment is most needed in the case of the thermodynamic papers, but the plan may be extended to cover Gibbs's writings on other subjects if it seems expedient. The financial support of the undertaking has been liberally provided for, and suitable honoraria will be paid to the authors of the new material.

The undersigned committee, appointed to study this plan, earnestly solicits suggestions and comments from all persons interested, especially with respect to any or all of the following questions:

- I. Which of the aims outlined above are the most important?
- II. How should the subject-matter be subdivided into parts which can be handled by a single author?
- III. What persons, irrespective of nationality, are best fitted by ability and training to undertake these different parts?

Letters containing suggestions or criticisms will be welcomed and may be addressed to the Gibbs Committee, Sterling Chemistry Laboratory, New Haven, Conn.

JOHN JOHNSTON,  
WILLIAM F. G. SWANN,  
RALPH G. VAN NAME, *Chairman*

YALE UNIVERSITY

## BARRO COLORADO ISLAND STATION

DR. THOMAS BARBOUR, chairman of the executive committee of the Institute for Research in Tropical America, has made his fourth annual report on Barro Colorado Island Station. It is a report of encouraging progress in the work and material development of the station.

"Redwood House," at the end of Armour trail, has been built of redwood lumber sent from California in order to test this lumber for resistance to termites. The new house is now completed and provided with everything necessary for a stay of several days. A new storeroom 28 feet long and 9 feet wide has also been built of redwood. An observation tower 28 feet high has been erected on the highest point of the island. Old trails have been extended and new ones laid out. Bridges have been made across some of the steepest ravines.

Among those who have carried on studies at the station during the year may be mentioned Dr. Frank M. Chapman, of the American Museum of Natural History; Dr. L. A. Kenoyer, head of the department of biology of Western State Normal School at Kalamazoo, Michigan; Dr. Josselyn Van Tyne, of the museum of zoology of the University of Michigan; Dr. Alfred O. Gross, professor of biology at Bowdoin College; Dr. George B. Wislocki, of the department of anatomy of the Johns Hopkins University; Dr. Curt P. Richter, of the Johns Hopkins Hospital; Miss Walburga A. Petersen, of the University of Wisconsin; Dr. Howard E. Enders, head of the biology department of Purdue University; Dr. Herbert Osborn, director of the Ohio Biological Survey; Dr. Thornton W. Burgess, of Springfield, Mass.; Dr. W. E. Hastings, of the conservation commission of Michigan, and Messrs. Ludlow Griscom and Maunsell S. Crosby, of the Museum of Comparative Zoology.

During the year a number of technical papers of importance have been published by various workers embodying the results of work on the Island and Isthmus.

The financial support of the station has continued to come from the University of Michigan, American Museum of Natural History, Harvard University, the Johns Hopkins University and Missouri Botanical Garden; from fees from scientific workers, and from

private sources, notably from Dr. Barbour and Mr. Allison V. Armour.

The station is in much need of larger financial support than it now has. Other institutions like those mentioned should make annual subscriptions. Any subscribing institution has the privilege of having its members given preferential treatment when there are more applicants for place than is available.

Applications for space should be made as far in advance as possible to Dr. Thomas Barbour, Museum of Comparative Zoology, Cambridge, Mass. Dr. Barbour will supply intending workers with all necessary information.

VERNON KELLOGG

NATIONAL RESEARCH COUNCIL

### APPROPRIATIONS OF THE GENERAL EDUCATION BOARD

THE General Education Board has issued its annual report giving an account of its activities during the year July 1, 1926, to June 30, 1927. Previous reports have called attention to the fact that the board has decided to transfer its main interest from college to university development. At the college level the general public, alumni, local communities and denominational agencies must mainly deal with the financial situation. The same can not be said of research and teaching at the research level. Men are relatively few; facilities are relatively undeveloped; public interest is still to be aroused.

In the field of science, exclusive of medical education, appropriations have been made as follows:

#### *California Institute of Technology*

The General Education Board has already cooperated with the California Institute of Technology in the development of its facilities for advanced work in physics, chemistry and mathematics. The authorities now plan further extensions in mathematical physics, biophysics and organic chemistry, and around these strengthened departments they hope to develop geology and biology, the former already established two years ago. The entire program, as now outlined, calls for additional endowment to the extent of \$4,000,000. In view, however, of the difficulty of procuring personnel, the program has been divided into two parts, and the institute is now undertaking to raise \$2,100,000. Towards this sum, the General Education Board appropriated \$1,050,000.

#### *Harvard University*

Harvard University, long eminent in respect to its personnel in the physical, biological and mathematical sciences, has only recently begun to procure adequate facilities for graduate studies. A new laboratory for

chemistry is now in process of construction; the biological laboratories and collections, now scattered, need to be brought together in as close proximity as possible to other sciences. It is proposed at this time to procure funds which will enable the university to devote the Jefferson Laboratory to undergraduate work and to construct and equip a fireproof building to be used for research and graduate instruction. To accomplish this improvement in the department of physics, the sum of \$1,100,000 is required. Towards this total, the General Education Board appropriated \$400,000.

#### *University of Chicago*

At the time of its foundation, the University of Chicago occupied an advanced position in respect to the physical and biological sciences. It is still eminent; but its accommodations remain practically what they were thirty years ago. With the exception of zoology, none of the physical and biological sciences possesses adequate space and equipment for research and the training of advanced students. The university has now undertaken to raise \$2,790,000, to be apportioned approximately as follows: botany, \$250,000; mathematics, physics and astronomy, \$1,600,000; chemistry, \$940,000.

Towards the total sum thus required, the General Education Board appropriated \$1,500,000.

#### *Vanderbilt University*

A few years ago Vanderbilt University established a school of medicine with ideals as exacting as those elsewhere in the country. This step rendered imperative an effort to lift the entire institution to a corresponding level. To achieve this end, an initial campaign was planned, calling for the sum of \$4,100,000 in three distinct portions—\$1,300,000 to be devoted to improving facilities in science, \$1,300,000 for improvement of work in the humanities and social sciences, \$1,500,000 for general endowment, the income to be utilized mainly in graduate work.

The first step has already been taken, and pledges amounting to the requisite sum have been secured. Towards the second and third steps the General Education Board has appropriated \$900,000.

### ANNUAL MEETING OF THE AMERICAN GEOPHYSICAL UNION

THE ninth annual meetings of the American Geophysical Union and of its sections will be held in Washington on April 26 and 27. A joint meeting of the sections of meteorology and oceanography will be held on both the morning and afternoon of April 26 and will be devoted to a symposium and discussion on interrelations between the sea and the atmosphere and the effect of these relations on weather and climate;

The 15 papers to be presented at this symposium will be grouped into (1) problems related to solar radiation, (2) problems related to surface-water temperature and (3) problems related to atmospheric circulation. The joint meeting of the sections of terrestrial magnetism and electricity, seismology and geodesy, to be held on the morning of April 26, will be devoted to a symposium and discussion on geophysical methods as applied in the study of geological structure; the program for the symposium will consist of six papers. The section of geodesy will hold a meeting on the morning of April 27 to hear reports of progress from representatives from Mexico, Canada and the United States, to be followed by a symposium on the figure of the earth. The section of volcanology will also meet on the morning of April 27, the program of scientific papers and discussion being devoted largely to questions of volcanic activity, the year's volcanologic publications and volcanologic work of the U. S. Geological Survey. The general assembly of the union is scheduled for the afternoon of April 27; in addition to business matters and reports concerned with the union's activities for the year, there will be reports of the delegates to the third general assembly of the International Geodetic and Geophysical Union at Prague and a general discussion with reference to the proposed publications of bulletins on geophysical methods, instruments, results, etc., under the auspices of the division of physical sciences of the National Research Council.

## SCIENTIFIC NOTES AND NEWS

A CELEBRATION in honor of the fiftieth anniversary of the invention of the dynamo will take place at the Franklin Institute, Philadelphia, on April 18, where the first tests were made in 1878 by Dr. Elihu Thomson and Professor E. J. Houston. Dr. Thomson and Dr. Charles F. Brush, who invented the type of dynamo finally recommended, will be the guests of honor and will present papers.

THE Frank Nelson Cole prize of \$200 for original work in algebra was awarded to Professor L. E. Dickson, of the University of Chicago, at a meeting of the American Mathematical Society at Columbia University on March 7. The prize, which is awarded every five years, was established in honor of Frank Nelson Cole, who was secretary of the society for twenty-five years.

THE University of Dublin will confer the honorary degree of D.Sc. on Dr. G. L. Streeter, director of the department of embryology, Carnegie Institution of Washington, Baltimore, and Professor A. S. Eddington, Plumian professor of astronomy and experimental philosophy in the University of Cambridge.

DR. CARL STUMPF, the distinguished psychologist, celebrates his eightieth birthday on April 21. On that occasion a bronze bust of him by Georg Kolbe will be unveiled in one of the rooms of the University of Berlin.

DR. ADOLPH ENGLER, professor of botany in the University of Berlin, has been elected an honorary member of the Russian Academy of Sciences.

DR. ALFRED DENKES, professor of medicine at the University of Halle, has been elected a corresponding member of the Royal Society of Medicine, London.

DR. PAUL ALEXANDROFF, professor of mathematics at Moscow, has been elected a corresponding member of the Göttingen Scientific Society.

THE gold medal of the British Institution of Mining and Metallurgy has been awarded to Sir Alfred Mond, "in recognition of his scientific and industrial services in the development of the mineral resources and metallurgical industries of the British Empire."

THE Frank N. Meyer medal for distinguished service in plant introduction has been presented to H. N. Ridley, in recognition of the important part he played in establishing plantations of the Para rubber tree in the Oriental tropics. The presentation was made by the American consul-general on behalf of Mr. David Fairchild, president of the American Genetic Association, to whom the award is entrusted by the staff of the office of foreign plant introduction of the United States Department of Agriculture.

WE learn from *Nature* that elections to the following offices in the British Chemical Society have been made: *President*, Professor J. F. Thorpe; *Treasurer*, Dr. T. Slater Price; *Secretary*, Professor T. S. Moore. The retiring president, Professor H. Brereton Baker, delivered his presidential address, entitled "Constitution of Liquids: Some New Experiments," at the annual general meeting on March 22.

DR. JOSEPH S. ILLICK, state forester of Pennsylvania, was elected chairman of the Allegheny section of The Society of American Foresters at the annual meeting held at Harrisburg. The Allegheny Section comprises the states of New Jersey, Delaware, Maryland, West Virginia and Pennsylvania.

By the operation of the age limitation law, Edward Howe Forbush will retire on April 24 from his position as director of the division of ornithology of the Massachusetts State Department of Agriculture. His work will be taken up temporarily by Dr. John B. May, who has been his assistant for some years.

PROFESSOR F. O. DUFOUR, head of the civil engineering department of Lafayette College, has resigned to accept a position as engineer in charge of structural

work with the United Engineers and Constructors Company, of New York and Philadelphia.

DR. JOSEPH FRANCIS MERRILL, after an official connection of thirty-five years with the University of Utah, thirty years of which time he served as director of the school of mines and engineering and professor of electrophysics, has accepted the position of commissioner of education of the Church of Jesus Christ of Latter-day Saints.

DR. JAMES F. NORRIS, director of the research laboratory of organic chemistry of the Massachusetts Institute of Technology, has undertaken the consulting editorship of the International Chemical Series, published by the McGraw-Hill Book Company. Dr. Norris succeeds the late Dr. H. P. Talbot.

THE managers of the Royal Institution have appointed Dr. Alex. Muller, known for his work on crystals, to be assistant director of the Davy Faraday Research Laboratory.

ACCORDING to *Nature* the appointments made by the British secretary of state for the colonies during the month of February, in addition to those for the East African Agricultural Research Institute, Tanganyika Territory, include the following: Dr. H. Scott, entomologist, Iraq; J. L. Illingworth, curator and agricultural superintendent, Virgin Islands; C. B. C. Handley, assistant agricultural officer, Kenya; Mr. H. Marsland, cotton investigator, Agricultural Department, Tanganyika Territory; R. S. Kyle, veterinary officer, Tanganyika Territory.

THE annual medical clinic of the State University of Iowa College of Medicine will be held at Iowa City from April 10 to 11. Dr. Dallas B. Phemister, professor of surgery, University of Chicago, will give an address, Tuesday evening, April 10, and Dr. Louis B. Wilson, Rochester, Minn., will give an address on Wednesday.

DR. HARRY B. WEISER, head of the department of chemistry of Rice Institute, Houston, Texas, will give two courses of thirty lectures each in the field of colloid chemistry in the forthcoming summer session at Western Reserve University, beginning on June 18.

DR. C.-E. A. WINSLOW, professor of public health at Yale University, has been appointed Cutter lecturer on preventive medicine for 1928-29 at Harvard University.

DR. GEORGE OTIS SMITH, director of the U. S. Geological Survey and newly elected president of the American Institute of Mining and Metallurgical Engineers, will deliver the commencement day address at the Colorado School of Mines.

DR. THOMAS ADDIS, professor of medicine at the Stanford University school of medicine, will deliver the seventh Harvey Society lecture at the New York Academy of Medicine, on Friday evening, April 27. His subject will be "The Renal Lesion in Bright's Disease."

DR. ROBERT BALK, of New York, addressed the Boston Geological Society, on March 23, on "Movements in Rocks."

ON March 31 Dr. Ralph Linton, of the Field Museum of Natural History, Chicago, delivered an address to the Royal Canadian Institute, on the subject "Two Years in Madagascar."

L. W. KEPHART, of the U. S. Department of Agriculture, will address the Philosophical Society of Washington, on April 14, on "Plant Hunting through East Africa."

DR. W. J. V. OSTERHOUT, of the Rockefeller Institute for Medical Research, has sailed for Bermuda, to spend three weeks at the biological laboratory.

DR. WILLIAM BEEBE, of the New York Zoological Society, has returned from a month's photographic expedition to the Florida Keys.

R. A. CUSHMAN, assistant custodian of hymenoptera at the U. S. National Museum, who went to the Philippines last fall to attend to the packing and shipment of the C. F. Baker collection of insects, which had been bequeathed to the museum, returned to Washington on March 27. The collection is now on its way to the museum.

SIR JOHN RUSSELL, director of the Rothamsted Experimental Station, will soon leave England to visit Australia, where he is going at the invitation of the Australian universities to lecture on the applications of science to agriculture.

DR. J. BRACE CHITTENDEN, professor of mathematics at the Brooklyn Polytechnic Institute, died on March 20, aged sixty-four years.

DR. CHARLES H. VIOL, director of the radium research laboratory of the Standard Chemical Company of Pittsburgh, died on April 6 at the age of forty-one years.

SIR AUBREY STRAHAN, formerly director of the Geological Survey of Great Britain and the Museum of Practical Geology, died at the age of seventy-five on March 4.

PROFESSOR ANTONIO ABETTI, director of the Astrophysical Observatory of the Royal University of Florence from 1894 to 1922, died at his home in Florence on February 20, in his eighty-second year.

ACCORDING to an Associated Press dispatch, Dr. Alexander A. Bogdanoff, director of the State Scientific Institute for Blood Transfusion at Moscow, died on April 8. It is reported that his death was caused by the effects of a transfusion experiment made on himself.

THE colleagues of the late dean of the Stanford University School of Medicine, Dr. Albion W. Hewlett, who died in 1925, have revised his book "Pathological Physiology of Internal Diseases—Functional Pathology," as a memorial. In the foreword the president of the university, Dr. Ray Lyman Wilbur, says: "Dr. Albion Walter Hewlett, the author of this book, was primarily a trained physiologist who developed into a skilled practitioner. No one in America was better fitted to present the various subjects covered."

ACCORDING to the will of Dr. William Charles Lawson Eglin, his collection of books, pamphlets and manuscripts relating to science and technology, one of the largest and most valuable privately owned collections of its kind in this country, will go to the Franklin Institute. Prior to his death on February 8, Dr. Eglin had given much of the collection to the institute, of which he was president.

THE Maryland chapter of Sigma Xi was installed at the University of Maryland on Friday afternoon, March 2, by the national treasurer, Dr. G. B. Pegram, of Columbia University. There were twenty-three charter members. After the installation ceremony there was a banquet. In the evening, addresses were given by Dr. Pegram and Dr. A. F. Woods, ex-president of the university. The chapter officers are: Dr. C. O. Appleman, dean of the graduate school, *president*, Dr. E. C. Auchter, *vice-president*, and Dr. M. M. Haring, *secretary-treasurer*.

A NEW organization, composed for the present of those interested in bacteriology in central California, to be known as the Society of Bacteriologists (geographically qualified by terms not yet defined), was organized in San Francisco on March 27. Dr. J. Russell Esty was elected *president*; Dr. William V. Cruess, *vice-president*; Dr. M. S. Marshall, *secretary-treasurer*, and Captain V. H. Cornell, M.C., U.S.A., and Dr. Harry E. Foster, *councillors*. Dr. Karl F. Meyer, director of the George Williams Hooper Foundation for Medical Research and professor of bacteriology of the University of California, addressed the meeting, giving his recent observations of research work being performed in various eastern institutions. At the close of the meeting 78 were definitely enrolled in the organization.

THE House Committee on Foreign Affairs on March 31 voted a favorable report on a resolution

to extend invitations to foreign nations to participate in the International Congress on Entomology to be held in the United States in 1928.

NEXT September a meeting of the International Illumination Commission, which was formed in 1900 and includes both gas and electrical interests, is to be held in the United States. The objects of the commission are the study of all subjects bearing on illumination and the cognate sciences and the establishment of international agreements in illumination matters. There are at present National Illumination Committees in Austria, Belgium, France, Germany, Great Britain, Holland, Italy, Japan, Switzerland and the United States. C. C. Paterson, director of the research laboratories of the General Electric Co., Ltd., Wembley, was unanimously voted president at the Bellagio meeting in September, 1927.

A NATIONAL agricultural museum and a research institute on rural affairs, both planned as centers of international interpretation and research, are being advocated by Dr. Nicholas Murray Butler, president of Columbia University. Dr. Butler estimates that \$50,000 would be needed to effect a realization of the institutions to work cooperatively with the present research work at Columbia.

A GIFT of \$180,000 by Eversley Childs, of New York, to establish a treatment station for the milder cases of leprosy at Cebu, in the Philippine Islands, has been announced by General James G. Harbord, national chairman of the Leonard Wood memorial for the eradication of leprosy. The new station will consist of laboratories, a medical center, clinics, wards, a pharmacy, a dispensary for out-patients, cottages for the staff and all necessary equipment.

NEW appropriations by the Kentucky legislature for research, topographic mapping and administration for the oncoming biennial budget of the Kentucky Geological Survey, amounting to \$264,000, are announced by Dr. Willard Rouse Jillson, state geologist. To this amount an additional \$30,000 has been added from the state highway revenues, making a sum of \$294,000 of state money available for the various activities during the coming biennium. Federal mapping funds to match a portion of this will be secured.

THE University of California College of Dentistry Alumni Association have announced plans for accumulating a \$50,000 fund, the interest of which will be used as a traveling fellowship to carry students of dentistry or allied subjects to other countries to study, or to bring students of other countries to California.

THE United States Department of Agriculture has organized an expedition, under the leadership of Dr.

E. W. Brandes, sugar plant specialist, which will use an airplane in searching the unexplored wilds of New Guinea for disease-resistant varieties of sugar cane that may prove valuable to the industry in Louisiana and other parts of the South. Dr. Brandes will sail from San Francisco April 12, accompanied by Dr. Jakob Jesweit, who was formerly chief of sugar-plant breeding work in Java and now of the University of Wageningen, Holland, and Richard K. Peck, who will pilot the plane. They will be joined at Honolulu by C. E. Pemberton, entomologist of the Hawaiian Sugar Plant Association Experiment Station, and proceed to Port Moresby, the base of the expedition on the southeast coast of New Guinea.

LECTURES will be given during April and May at the New York Botanical Garden on Saturday afternoons at 4:00 P. M. as follows: April 7, "Beauties from the Flower Shows," Kenneth R. Boynton; April 14, "On the Long's Peak Trail," Howard H. Cleaves; April 21, "Gladiolus, Wild and Cultivated," Dr. Forman T. McLean; April 28, "Insects of Shade Trees and Ornamentals," Dr. E. P. Felt; May 5, "Daffodils," B. Y. Morrison; May 12, "Farming for Bouquets on the Cote d'Azur," Mrs. Wheeler H. Peckham; May 19, "How to Study Ferns," Professor Henry J. Fry, and May 26, "Chinese Asters," Professor Roland H. Patch.

THE summer school for engineering teachers which was established by the Society for the Promotion of Engineering Education in 1927 is to continue its sessions during the coming summer. Two schools will be held: one for teachers of physics and the other for teachers of electrical engineering. As in 1927, when mechanics was the subject studied, the purpose will be to study the principles and methods of teaching rather than to review actual content of subject-matter. The session on the teaching of physics will be held at the Massachusetts Institute of Technology, under the directorship of Dr. S. W. Stratton, president of the institute. The session on electrical engineering will be held at Pittsburgh, under the joint auspices of the University of Pittsburgh and the Westinghouse Electric and Manufacturing Company. Dr. F. L. Bishop, of the University of Pittsburgh, secretary of the Society for the Promotion of Engineering Education, and Professor Charles F. Scott, of Yale University, chairman of the society's board of investigation and coordination, will serve as codirectors of the Pittsburgh session of the school. Professor H. P. Hammond, associate director of the society's investigation of engineering education, is in general charge of the school. Both sessions will be of three weeks' duration and will begin shortly after July 4.

THE Rockefeller Foundation has taken action converting its previously made pledge to an appropriation of \$312,500 for the support of fellowships in physics, chemistry and mathematics by the National Research Council during the years 1928 to 1930, inclusive, at the rate of \$125,000 a year for 1928 and 1929, and \$62,500 for the year 1930.

## UNIVERSITY AND EDUCATIONAL NOTES

DARTMOUTH COLLEGE will receive about \$1,500,000 from the estate of the late Edwin Webster Sanborn.

PHILIP S. BIEGLER, professor of electrical engineering at the University of Southern California, has been appointed acting dean of the college of engineering just created at that institution.

PROFESSOR LESTER S. GRANT, dean of the faculty and professor of mining engineering at the Colorado School of Mines, has resigned.

PROFESSOR A. I. KENDALL has left the medical school of Washington University to become research professor of bacteriology at Northwestern University.

DR. CLARENCE ERROL FERREE, of Bryn Mawr College, has been appointed resident lecturer at Wilmer Institute at the Hopkins Medical School and director of the research laboratory in physiological optics.

DR. ERICH BRENNECKE, of the Geodetic Institute in Potsdam, has been called to the professorship of geodesy at the Berlin Institute of Technology.

## DISCUSSION AND CORRESPONDENCE

### THE AURORA OF MARCH 28, 1928

THE peculiar combination of an aurora with a lunar halo as visible in Cambridge on the night of March 28 is such an unusual occurrence that the event seems deserving of more than passing mention.

The lunar halo first attracted my attention about 11 P. M., Eastern Standard Time. A few minutes later the halo bore a fringe strikingly suggestive of a solar corona. By 11:30 a well-defined auroral fan was centered at a point on the horizon directly under the moon (at first quarter) with a streamer extending from the horizon directly past the moon and vertically upward. Oblique streamers arranged themselves approximately symmetrically about this line. One of these passed above Capella and at 11:50 P. M. extended across Polaris, and between Vega and Hercules to the eastern horizon.

A similar brilliant streamer mounting from the auroral center extended southward, passing Procyon and Regulus in Leo. These two streamers crossed the

lunar halo very nearly on the same circle of altitude as the moon and the crossing points were marked by exceptionally brilliant patches of auroral light. The outstanding feature of the phenomenon was the existence of horizontal streamers extending several degrees through the patches and diverted away from the moon as an apparent radiant point. These horizontal streamers with an apparent radiant at the center of the halo made angles of  $20^{\circ}$ – $30^{\circ}$  with the long auroral streamers but gave every appearance of a true auroral effect. The distance of one of the bright patches from the moon was observed with a sextant and found to be  $25^{\circ}$ , thus fixing the radius of the lunar halo. The large halo vanished at 11:50 P. M., whereupon a smaller ring of  $4^{\circ}$  radius appeared about the moon. This in turn vanished at midnight. At 12:10 A. M. the large  $25^{\circ}$  halo returned for about five minutes and at 12:20 A. M. a symmetrical cross with horizontal and vertical beams appeared across the moon's disk. Shortly after 1 A. M. a light cirrus stratus had developed and the aurora faded. The temperature was  $30^{\circ}$  F. There had been a fall of  $33^{\circ}$  F. since the day previous.

The combination of the optical effects in an all but invisible cirrus stratus with a true auroral glow gave a suggestion of the problem encountered in a study of the solar corona, where we may very well have light from electrical excitation mixed with an optical corona formed from minute particles comprising a circulating circumsolar cloud.

The effect of the auroral streamers at presumably an altitude of four or five hundred miles, combined with optical phenomena in a layer of cirrus at an altitude of four or five miles gives one food for thought.

On examining our sunspot photograms the following day a spot of marked intensity passed within  $5^{\circ}$  of the sun-earth line on midnight, Eastern Standard Time, March 28–29. The field strength of WBBM as measured on the automatic radio recorder 9–10 P. M., March 28, was exceptionally low and the static heavy.

H. T. STETSON

ASTRONOMICAL LABORATORY,  
HARVARD UNIVERSITY

### "WASHBOARD" OR "CORDUROY" EFFECT DUE TO THE TRAVEL OF AUTOMOBILES OVER DIRT AND GRAVELED ROADS

SEVERAL articles have appeared in *SCIENCE*<sup>1</sup> dealing

<sup>1</sup> Dodd, L. E., "'Washboard' or 'Corduoy' Effect due to the Travel of Automobiles over Dirt Roads," *SCIENCE*, September 2, 1927, 214–16.

Ruckmick, Christian A., "'Washboard' or 'Corduoy' Effect due to the Travel of Automobiles over Dirt Roads," *SCIENCE*, November 18, 1927, 481–82.

with the subject of washboarding of highways and there are some confirmations and some new ideas I would like to present.

In regard to the washboards themselves, the term is in common use in the Pacific Northwest where practically every graveled road is afflicted with them. In the semiarid regions, during the drier seasons, these corrugations develop to considerable size and the maintenance of roads is a very difficult problem. No sooner is a newly graveled road opened to traffic than the washboards develop and there they stay, increasing in size until the grading crew removes them, temporarily.

It should be noted that it is the high-speed traffic that causes the washboarding. Horse-drawn vehicles do not develop these road-waves, nor do heavy trucks, which pound a road into many spring-breaking chuck-holes. It is the pleasure car with its pneumatic tires and high rate of speed that appears to do the damage. Tires with new treads can throw loose pieces of road metal with considerable violence, in fact the writer was recently in a car which had its windshield broken by a passing car throwing a small pebble.

Loose gravel does not appear to develop washboarding until a portion of the surface has become hard enough to wave. This is of importance in road maintenance, for dirt binders are frequently added to pack the crushed rock, and thus automatically increase the liability of washboarding.

The writer was employed by the Washington State Highway for some time. Washboarding was an important maintenance problem, in fact one of the biggest. The opinion was reached that when the rear wheels of the car hit a small bump they begin vibrating. The resultant spin of the wheels while they are in the air digs out small depressions when they hit, and the corrugations grow in the line of travel with each succeeding car. On roads covered with loose gravel, an experienced driver can frequently find relief by driving a few inches to one side of the well-packed rut and thus escape part of the vicious, neck-breaking vibrations. However, he simply widens the washboarding and soon they extend across the road.

With this idea in mind, the following experiment was performed on a newly graded and graveled road between Yakima and Ellensburg, Washington, under the direction of Max L. Mook, District Engineer for the state highway department. The road grade had been allowed to settle for a year, then dragged and graded and treated with fine crushed basaltic rock to which a small amount of dirt binder had been added. The road was opened in perfect condition. The in-

spection party stationed themselves on either side of a fill with the level of their eyes at the road grade, and a three-fourths-inch rope was stretched across the grade. As the cars hit the rope, the rear wheels were set into vibrations which continued for some distance, and each time the wheels hit the road grade they were observed to throw small amounts of gravel. Within a short time a beautiful set of washboards extended away from the rope but on the approach side little or no corrugations were observed. It might be added that in two weeks' time the road was so badly washboarded that it was necessary to put on a grading crew to resurface the road.

In this semiarid country, the driver's chief object is to get over the road just as quickly as the uniformed motorcycle patrol will allow him. Washboards will develop. It is hoped that road oil, used to reduce the dust menace, will alleviate the damage somewhat. Even the widely praised black-top or bithulitic pavements washboard in hot weather. It appears that the solution is to be found in either leaving the car at home, or in paving with concrete.

RAY C. TREASHER

LIVINGSTON, MONTANA

FOLLOWING the discussion and correspondence on the "Washboarding" or corduroy effect on roads traveled by automobiles by L. E. Dodd and Christian A. Ruckmick in the issues of September 2 and November 18, I have a version to contribute. Mr. Dodd's physics is beyond dispute, but my addition is to the road scraper theory. I have seen this sort of ripple on tar and macadam roads. Scrapers are not used on the surfaces of these, although they may be used in leveling the work before the hard surface is put on, and any initial roughness may be imparted up to the surface. Again, in leveling off the surface of macadam a straight edge board is often used, a man on each end pushing it along, but any waviness here would be very minute.

Last summer I was returning by motor from a trip into the Province of Quebec. All the crushed rock and gravel surface roads between the St. Lawrence River and the New England line are very "washboardy." Canada has some very good roads and some very poor ones, concrete and macadam in proportion to the size of the country with the United States, but in this eastern township's part of Quebec the main route north from New England is not yet all hard surface across the line, although roads are very good. You see a great many more horses belonging to the farmers, perhaps one Ford to each farm and a lot of auto tourist cars.

Having crossed back down into Vermont where the macadam began again, I was driving along, when

there turned into the highway ahead of me a team of horses drawing a load of hay. It was a warm day, and as is the case when macadam becomes soft with the heat of the day, the heels of a man's shoe or the shoes on the horses sank into the tar slightly, leaving a small mark or hole. A team of horses, walking along a road as I could watch these walking, leave their hoof prints at regular spaces. As I drove along behind, before passing, I noticed how evenly, and, as near as I could judge by eye, this spacing was the same as the wave-lengths of the washboarding. After a team has gone along like this, the automobiles, coming along afterward, will pick up the little loose bits of tar dug up by the calks of the shoes, and by the friction, suction and so forth of the tire treads, hollow out the depression more and more.

The large number of these roads in Canada, as it may be in the West, corresponded, I thought, with the greater number of horses still there. I should say there were fifty per cent. more horses than in New England and New York, where farming is in many places on the decline.

The reason why the concrete roads do not washboard is because they have too hard a surface for the horses' iron to indent. Because, even though the concrete is so much harder, if there were any initial unsmoothness in the construction, either in using a scraper in the leveling of the bed above the subbase or in smoothing off the newly poured cement, in time, heavy automobile or truck tires would cause this effect. Often you do see a certain slight roughness in a concrete road (I mean aside from the cracking), which has come there by the hand smoothing of the men pushing the smoothing board over it, and a slight vibration results, but this never enlarges to the common washboard size.

ELLWOOD WILSON

CAMBRIDGE, MASS.

#### A NOTE ON OVARIAN SECRETION AND CANCER

IN an article published in the issue of *SCIENCE*, for December 16, 1927, I gave a short preliminary report of work done upon the effect of ovarian secretions on the incidence of mammary cancer in a stock of dilute brown mice. One of the primary objects of the paper was to report the successful feminization of castrated males, by means of ovarian transplants, to the extent that they developed, spontaneously, mammary tumors; a thing which thousands of unoperated male mice of this stock have not done.

In *SCIENCE* of January 27, 1928, Dr. Leo Loeb calls me to task for not quoting him exhaustively in my bibliography and lists two "extensive" reports of his which I did not mention, thus creating in his opinion,

an "erroneous impression as to the development of our knowledge of this problem."

In a brief report such as mine, it is obvious that an extended bibliography would have been out of place. It seemed, moreover, advisable not to make any further reference to Dr. Loeb's work because of the following facts:

(a) The mixed stocks used in his experiments were raised outside of his own laboratory and their ages were only approximately recorded, while the mice which I used have been inbred brother to sister under constant observation since 1909, the exact date of birth of each animal being recorded.

(b) Loeb's youngest class of spayed animals was three to six months old at castration; they may or may not have been bred previous to this. He makes no statement regarding this point, whereas my female mice were all castrated within the 28 to 35-day period and were virgins.

(c) In his total of 133 castrated animals, 98 were non-tumorous, while 35, or 26.3 per cent., were tumorous. These findings he considers significantly different from his 63 non-breeding animals (virgins), 44 of which were non-tumorous and 19, or 30.1 per cent., of which were tumorous. It seems that should a probable error be applied to these figures, there would be no significant difference between them. This fact is shown more conclusively if the totals for my experiment, shown below, are compared with his, mentioned above.

Virgin females, 207; Cancerous 20, or 9.6 per cent.; Non-cancerous 187.

Spayed females, 210; Cancerous 21, or 10 per cent.; Non-cancerous 189.

This provides clear evidence that his statement "prevention of breeding has some influence on the cancer incidence in mice but to a much less extent than castration" is entirely unconfirmed by experiments more than twice as extensive as were his.

(d) In that part of his experiment in which he attempted to "feminize" castrated males by implanting ovaries, he used a grand total of 19 animals, none of which developed mammary tumors.

In my experiment 210 animals were used for operation and four developed mammary tumors.<sup>1</sup>

This in turn provides clear evidence that his conclusion that the "transplanted ovaries are probably not able to call forth rhythmic growth changes in the mammary gland . . . and consequently cancer is not induced in such animals as the result of the experimental procedure" is totally contrary to the fact

<sup>1</sup> Since my paper was published, seven additional males in this experiment have developed mammary tumors and many of the animals are yet alive.

obtained in a series more than ten times as extensive as his own.

Without the positive evidence that it is possible to cause mammary tumors by transplanting ovaries to the bodies of castrated males, the statement that ovarian hormones are one of the factors in the etiology of mammary cancer seems to lack final confirmation. Such proof was not provided by Loeb's work.

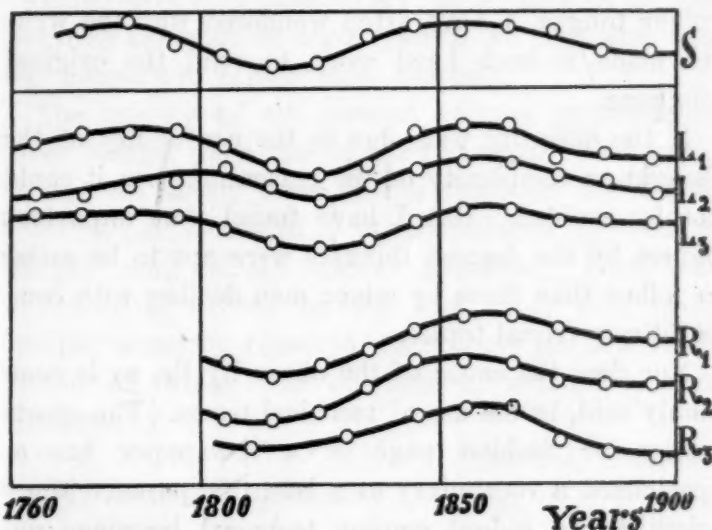
In view of these facts, it still seems that it would have been better had Dr. Loeb not forced a consideration of the earlier papers to which he referred.

WILLIAM S. MURRAY

LABORATORY OF MAMMAL GENETICS,  
UNIVERSITY OF MICHIGAN

### ON A RELATION OF THE SUN'S ACTIVITY TO SOME BIOLOGICAL FACTORS

THE relation between the activity of the sun and different physical and biological factors on the earth can be illustrated by the following curves. The curve S gives the number of sun spots as a measure of the sun's activity (Wolf). Curve L<sub>1</sub> gives the relative



numbers of births, L<sub>2</sub>—deaths and L<sub>3</sub>—marriages for Leningrad and the curves R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub> give the same numbers for all the territory of Russia. In all cases there are given means for ten years. It would be of interest to find the same relations for other countries.

G. I. POKROWSKI

PHYSICAL INSTITUTE OF THE SCHOOL  
OF TECHNOLOGY, MOSCOW

### THE SHARP RATTLING IN STEAM-PIPES

WHEN the water in a cryophorus is at a temperature somewhat above freezing, it is possible to trap bubbles of water vapor in the liquid column by holding the cryophorus horizontally. Under the proper conditions of pressure due to motion of the liquid column, the bubble of water vapor will suddenly condense, causing the water surfaces of the bubble to come together with a sharp click.

This observation is at once applicable to the steam in radiator pipes. Most text-books in physics give the following explanation: "The sharp rattling noise in steam pipes is due to the water hammer. A column of condensed water is driven along the pipe by the steam, the cooler steam ahead of the column condenses, and the column of water hammers against the end of the pipe or against a stationary body of water in the pipe." This description of the phenomenon is correct as far as it goes, but it fails to emphasize the fact that for the sharp clicks the whole mass of water vapor between the two surfaces of water (that is, the bubble) *condenses into water instantaneously*.

The observations upon the bubbles in the cryophorus were made by my assistant, Mr. Lee Fullmer, who also differentiated the sharp clicks in the steam-pipes from the duller thud of the water hammer.

R. C. COLWELL

WEST VIRGINIA UNIVERSITY

### SCIENTIFIC OBSCURITY

SINCE it has been my lot for many years to earn my living by translating scientific literature into the vulgar tongue, I have often wondered why the writers made it such hard work to read the original language.

If the difficulty were due to the profundity of the thought or complexity of the reasoning, then it could not be avoided. But I have found that important papers by the deepest thinkers were apt to be easier to follow than those by minor men dealing with comparatively trivial topics.

Nor does the cause of the obscurity lie, as is commonly said, in the use of technical terms. The sports section or fashion page of a newspaper has as specialized a vocabulary as a scientific paper. Many scientists do indeed employ technical language unnecessarily in writing for the outside public, but even where the words are all familiar the meaning may still be obscure.

I have come to the conclusion that the chief reason why scientific literature offers such high resistance to reading is the use of the alternating current instead of the direct in conveying the thought. The writer interposes a negative every few words that reverses the meaning of the sentence. This keeps the reader on the jump.

The asymptotic ideal toward which scientific writing tends is a sentence structure something like this:

The present writer is indisposed to deny that he is unconvinced of the necessity of refusing to accept the infrequency of negative reactions as a not insuperable argument in disproof of the theory.

Such sentences may be quite logical and free from

technical terms. They can be disentangled in time and when straightened out the meaning may turn out to be something simpler than it sounds. But they are constructed like the Chinese boxes, when you get one opened you come on to another. The process of extracting the meaning is like the simplification of a complicated algebraic equation, and in extricating the internested parentheses you are likely to come out with the plus and minus signs mixed.

In conclusion, the present writer is indisposed to deny that he put the wrong title at the top of the letter. It should be, not "Scientific Obscurity" but "Unscientific Obscurity in Writing on Scientific Subjects."

EDWIN E. SLOSSON

SCIENCE SERVICE,  
WASHINGTON, D. C.

### SCIENTIFIC BOOKS

*Birds of the Pacific States.* By RALPH HOFFMANN. Boston, Houghton Mifflin Co., xix + 1-353 pp., with 10 color plates, and over 200 black and white illustrations, by Major Allan Brooks. 1927.

THE diversity of native animal and plant life in the Pacific states has long been a source of attraction for students of biology, but beginning acquaintance with the fauna and flora has heretofore been hampered by the lack of suitable manuals. This need is now in process of being satisfied, as during the past three years there have appeared four important keys which will help to unlock the doors leading to accurate knowledge of the western biota. Jepson's "Manual of the Flowering Plants of California" is the first state-wide botanical key for California; Essig's "Insects of western North America" is the very first comprehensive western volume in entomology; Johnson and Snook's "Seashore Animals of the Pacific Coast" is the pioneer volume in the popularizing of western marine biology; and Hoffmann's "Birds of the Pacific States," while preceded by other volumes dealing with birds, easily stands premier as a manual for field ornithology in the west.

Most bird students are interested in the living bird, and in the early stages of their interest they are concerned chiefly with the problem of identification in the field. Despite this obvious fact, a majority of the bird books heretofore issued have ignored or given but minor attention to this phase of the subject. Mr. Hoffmann was, and still is, a pioneer in the production of workable field manuals. In 1904 there appeared his "Guide to the Birds of New England and eastern New York" which dealt with "over two hundred and fifty species with particular reference to their appearance in the field." For the novice this volume is still the best field book of birds for the area

indicated. The present contribution treats of more than four hundred western species from the standpoint of their field appearance and behavior.

"Birds of the Pacific States" is a compact volume (one and one-eighth by five and three-eighths by seven and five-eighths inches) substantially bound in green buckram, and hence suited for actual field use. The style is terse, an element of the contract which produced a volume useful from Vancouver Island to San Diego and from the Pacific Ocean to the Great Basin. The appearance, voice and movements of the bird, its habitat preference and the ways in which it may be differentiated from other species of similar appearance constitute the principal parts of the text of the species chapters. The plumage, geographic range and nesting habits are set forth briefly, following the paragraphs dealing with identification. The *species* is (with one or two exceptions) the unit of consideration; subspecies are listed with their respective ranges but without reference to their characters. The book follows the "new" or revised classification and sequence which will be used in the forthcoming Fourth Edition of the American Ornithologists' Union checklist and which American bird students will soon be forced to learn.

The illustrations merit special mention. All are by Allan Brooks and all are *new*. There are ten plates in color, showing in all forty-seven species. In several instances both males and females are figured. The plates are not quite right in this impression; either the etching or inking is slightly in error, giving too much red in several figures, a fault which can be corrected in future printings. The black-and-white illustrations are from pen-and-ink sketches, a medium seldom used heretofore by Brooks, but one which he has handled exceedingly well. Differences in color are indicated by different types of line treatment so that the student obtains a very good idea of the distribution of color masses on the bird. Here again some of the figures are of groups of two or three species or exhibit differences in plumage due to sex or season so that, in all, upwards of 60 per cent. of the species are shown either in color or line. The reviewer is of the impression that, in general, black and white illustrations are better than color for the beginning student, although the novice will probably believe the contrary to be true. The element of conservation in identification is involved here, an item which also is stressed by our author.

Among the thousands of items of record in the volume under discussion a few—a very few—catch the eye as errors or omissions. The iris of the barn owl is dark, not yellow (p. 161), the pileated woodpecker resides in the Coast Ranges from Lake and Mendocino counties northward as well as in the Sierra Nevada (p. 193), the breeding range of the robin

scarcely includes the Sierran foothills (p. 259) but begins with the yellow pine forest; it also nests at various places in the Coast Ranges and locally in the lowlands of California. The ecologic preferences of certain species are even more restricted than indicated. The Bell sparrow (p. 326) is a bird of the greasewood (*Adenostoma*) chaparral, the rufous-crowned sparrow (p. 327) chiefly of the "old-man" sage (*Adenostoma californica*). It would have been helpful to indicate (for the beginner) the meaning of the few abbreviations used, and dimensions for nests and eggs would have aided in field identification of accessories.

This volume is built upon the principle that the habits of birds are, in general, so stable that we can predict their behavior and can use behavior as a means of field identification. This point, although well known to critical teachers of ornithology, has not found adequate expression heretofore in field manuals. The habits of birds are specific characters no less than the details of skeletal structure, soft parts and feather architecture. Mr. Hoffmann has written his book largely upon this basis and has produced a "comparative field ornithology" or a "manual of comparative behavior of birds" which we can rank with our manuals of comparative anatomy.

The quality of the present volume rests, among other things, upon the author's energetic field work; during his seven years of residence on the Pacific coast he has succeeded in observing alive upwards of 95 per cent. of the species described. First-hand impressions, written on the spot, and, with many species, tested by repeated contact, are the firm foundation on which this outstanding manual is constructed.

TRACY I. STORER

UNIVERSITY OF CALIFORNIA

*Textbook of Comparative Physiology.* By CHARLES GARNER ROGERS. McGraw-Hill Co., N. Y., 1927.

ROGERS' book on comparative physiology of animals is the most comprehensive discussion in this neglected field that has yet appeared in a single volume in the English language. Emphasis in recent years on the teaching of physiology under pressure for direct training in subject-matter for immediate practical application in the arts of medicine and of agriculture has led to the extreme development of human and mammalian physiology to the exclusion of that degree of comparative training which we accept without question as necessary for cytology and for anatomy.

There are twenty-nine chapters on the subjects of properties of protoplasm, the cell, general phenomena of life, organ systems, the transport system, the blood as an oxygen carrier, catalytic actions of animals, and the more conventional topics on secretion, nutrition of animals, circulatory mechanisms, physiology

of the heart, etc. The chapter on the nervous system has eighty odd pages of an exceptionally able discussion of the origin and development of the nervous system as a coordinating mechanism. It is illustrated by examples drawn from a great variety of nervous organizations from the neuromuscular apparatus of the protozoa and the nerve net of the coelenterates to the neurone and the synaptic systems of a wide range of invertebrate and vertebrate nervous systems. The segmental nature of the nervous system is presented by discussion of the functional behavior of a well-chosen series of invertebrates in which the chain ganglia are still distinct.

There are able discussions of several topics peculiar to comparative physiology, for example, the functions of the swim bladder as a static organ. However, the important problem of animal luminescence seems to be wholly neglected.

At the close of the volume are references to selected literature of value to the investigator in the field.

This volume should have a distinct influence in rescuing the subject of physiology from the restrictive dominance of the arts and to that extent should give back to practical medicine and to agriculture correspondingly broader training in the basic physiological sciences.

C. W. GREENE

## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### THE COLLODION METHOD AND SERIAL SECTIONS

THE collodion (celloidin) method is admitted to give better effects than can be secured by the use of paraffin on a number of tissues, while for certain material, *e.g.*, grasshopper eggs, it is the only known means of securing satisfactory results. Nevertheless, there is a general reluctance to use collodion due chiefly to the belief that it is difficult to preserve the serial order of the sections by this method. In reality, mounting in serial order is very easily accomplished and, while the collodion method is slightly slower than the paraffin method, with some simplification of details it is easier, in many respects, to handle. This article contains little that is new, but the various points are so scattered through scientific papers that it seems desirable to make the whole procedure available.

*Preliminary steps.* The first part of the process is the same as for the paraffin method. Dehydration must be completed by the use of absolute alcohol since "clearing" oil is not used. The principle involved in clearing, however, is employed, *e.g.*, the tissue is saturated with a solution which is miscible with the

infiltrating substance, namely, a mixture of equal parts of absolute alcohol and ether.

*Infiltration and embedding.* The usual method of accomplishing these processes by two distinct steps is largely responsible for the prevalent idea that the collodion method is necessarily cumbersome. However, they may be combined in a very simple way by using a shell-vial or a similar vessel of suitable size as a container. It is desirable that the container should not have a neck in order to facilitate the later removal of the hardened mass.

Tri-nitro-cellulose under some of its trade names (collodion, celloidin, parlodion, etc.) is dissolved in equal parts of absolute alcohol and ether and used as the infiltrating medium. The solution, which ordinarily should be fairly thin, readily penetrates without heat tissues which are already saturated with the solvents. The time required varies widely. Usually the container is kept tightly closed for several days or in some cases even weeks or months. The cover is then slightly loosened to permit a very gradual evaporation of the solvents with a corresponding concentration of the collodion in the tissue. When the solution has become fairly viscous the tissue is oriented as desired. After the mass becomes firm it should be loosened about the edge so that it will contract away from the vial. When it has become sufficiently solid it can be removed easily. Evaporation should occupy several days; if sufficient time is not given the mass will not be of uniform density.

*Hardening and blocking.* The mass is trimmed, leaving about 1 mm. of collodion about the tissue and a flat base for mounting. It is then returned to the vial together with a piece of cotton saturated with chloroform for further hardening. The block may be stored in 70 per cent. or 80 per cent. alcohol indefinitely, but it should be hard enough for sectioning before it is placed in the alcohol. The necessity for again dehydrating, however, is obviated if the block containing the tissue is mounted on a proper support before placing in alcohol. The simplest procedure is to take the block directly from the chloroform vapor, stand the base for a moment in alcohol and ether to soften it, then transfer quickly to a fibroid block, the top side of which has just received two or three drops of thick collodion. After not more than ten minutes' exposure to the air, in order that the collodion may set, the whole is placed either in chloroform vapor for further hardening, or, if the mount is small, directly in 70 per cent. alcohol, where it should remain for several hours before sectioning in order that the entire mount may become very firm.

*Cutting and mounting of sections.* Collodion sections are cut with the knife placed at the least possible angle to the direction of movement. The

knife is kept wet during the process, usually with 65 per cent. to 70 per cent. alcohol. This may conveniently be accomplished by arranging an automatic cup so that it will drop the alcohol on the knife at the desired rate. The cutting should be done with quick, firm motion. If the block has been sufficiently hardened and the knife edge is in good condition every section should be perfect and the thickness of successive sections uniform. A small sable brush is best for handling the sections. The brush is kept wet with the alcohol on the knife and if the sections are to be mounted serially they are arranged near the back of the knife from right to left as they are cut, always keeping them moist. Several rows of the proper length to fit under the cover-glass may be so arranged in the relation to each other which they are to occupy on the slide. A thin piece of tissue paper is placed smoothly over the sections, being sure that there is sufficient alcohol to wet through the paper. With a uniform downward motion the paper is pulled off the knife, preferably over the back. The sections sticking flat to the paper are carried across to a chemically clean slip on which the paper is laid reversed so that the first section cut occupies the upper left hand corner and so that the sections are properly centered. The paper may be smoothed out with the addition of a small amount of alcohol if necessary. Several layers of absorbent paper are placed on top and the whole rolled lightly but firmly with some cylindrical object for about ten seconds. This, in addition to pressing the sections tightly against the glass, removes the 70 per cent. alcohol. The paper is then quickly peeled off, leaving the sections on the slide where they are instantly flooded with clove oil, which should remain until the sections are perfectly translucent. The clove oil will dissolve sufficient of the collodion to fasten the sections to the slip; after about eight minutes the surplus oil is drained off and the slide placed in 95 per cent. alcohol. After ten or fifteen minutes it is changed to fresh 95 per cent. alcohol to insure the complete removal of the clove oil. From this point on the preparation is treated the same as if it contained paraffin sections except that the collodion is not removed. Dr. Miriam J. Scott is authority for the statement that some of her slides, so prepared, were kept in 70 per cent. alcohol for two months without the loss of a section. An equally satisfactory method, if properly used, is to smear the surface of the chemically clean slip with a film of Mayer's albumen, place the sections on it as directed above, and, omitting the clove oil, immerse quickly in 95 per cent. alcohol for at least ten minutes. One small drop of Mayer's albumen is sufficient to prepare 25 or 30 slips. Any considerable amount of albumen precipitated under the sections

impairs the stain and lessens the probability of the sections remaining on the slip.

*Cautions.* (1) The block must be sufficiently hard to be quite rigid, otherwise its elasticity will interfere with cutting perfect sections such as are necessary for serial preparations. The proper degree of hardness should be obtained before placing in 70 per cent. alcohol.

(2) The slip must be chemically clean. It may be tested in this respect by placing a drop of distilled water on its surface. It is satisfactory if the water spreads uniformly and does not roll off when the slip is tilted without wetting the glass. (This is the most important of the precautions.)

(3) Just after the sections have been placed on the slide there is a moment when very precise work is necessary. After they are covered with the absorbent paper, they must be rolled long enough to remove practically all of the 70 per cent. alcohol except what is actually in the sections; when this condition has been obtained, speed is necessary in order to remove the paper and get the sections covered with the next medium before air gets between them and the slip, owing to the evaporation of the alcohol which is in the sections.

E. ELEANOR CAROTHERS

UNIVERSITY OF PENNSYLVANIA

## SPECIAL ARTICLES

### DIRECT EVIDENCE OF ATOM BUILDING<sup>1</sup>

THROUGH new and more precise measurements on cosmic rays than those heretofore made, Millikan and Cameron have just succeeded in bringing forth quantitative evidence that those rays represent the precise amount of energy which should, according to Einstein's equation showing the relation of mass to energy, be emitted in the form of ether waves when the primordial positive and negative electrons unite to create helium atoms and other light atoms such as oxygen and silicon, magnesium and iron.

Millikan and Cameron have investigated these rays through experiments in high mountain lakes, both in California and in Bolivia, and Millikan and Bowen have studied them with the aid of self-recording electroscopes sent up by sounding balloons which reached nine tenths of the way to the top of the earth's atmosphere.

The results obtained in such investigations during the past eight months constitute the first indubitable evidence that the cosmic rays on which they have been experimenting, instead of being spread like white light

<sup>1</sup> A report made in Pasadena to the California Institute Association on March 16.

over a considerable spectral region, consist of bands of definite frequency, or color, like the light from a neon lamp or from a Cooper-Hewitt mercury arc.

The general spectral region, however, in which these bands are found, corresponds to frequencies 100,000,000,000 times greater than those emitted by the aforementioned lamps. This is why these cosmic radiations are powerful enough to penetrate 200 feet down into a mountain lake before they are completely absorbed.

The rays brought to light by this most recent work correspond to four main radiations extending over a spectral region three octaves wide and having frequencies identical with those which are computed theoretically from the loss of mass which would occur in accordance with the foregoing equation of Einstein, first, when the helium atom is created out of the nucleus of the hydrogen atom (the positive electron) two negative electrons acting as the binding agents; second, when oxygen and nitrogen atoms are similarly created out of hydrogen; third, when silicon and magnesium are so produced, and, fourth, when the atom of iron is born.

Hydrogen and helium are extraordinarily abundant gases, while the four elements—oxygen, magnesium, silicon and iron—are the most abundant elements found in meteorites and constitute a not unlike percentage of the earth. The agreement between the observed and computed frequencies is so good as to make it highly improbable that it represents an accidental coincidence.

The quantitative nature of the agreements obtained is illustrated as follows: While the atomic weight of hydrogen is 1.00778, the atomic weight of helium is 4.00054; when helium is created by the union of four hydrogen atoms an amount of matter disappears which is equal to four times 0.00778.

The difference—namely, .03058 grams—must, according to Einstein's equation ( $MC^2 = E$ ), go off in the form of radiant energy when the helium atom is formed, and the appearance of this amount of energy in the form of a monochromatic ether wave would give that ether wave the penetrating power which is represented by an absorption coefficient numerically equal to .305.

This is within a few per cent. of the absorption coefficient directly observed by Millikan and Cameron for the most conspicuous band in their cosmic ray spectrum.

There is, further, a philosophic argument which supports the results of this observation. We have long known that all elements have a structure which indicates that they are exact multiples of the mass of the positive electron, which is the nucleus of the hydrogen atom.

We have also known for thirty years that in the

radio-active process the heavier atoms are disintegrating into lighter ones. It is, therefore, to be expected that somewhere in the universe the building-up process is going on to replace the tearing-down process represented by radio activity.

Up to the present, however, no evidence had ever been found that this building-up or creative process is going on now. The present experiments constitute the first discovery of such evidence.

It must be taken with some reserve and must be subjected to further critical analysis and further experimental tests. But, so far as they go, these experiments are at least indications, and the first direct indications, that all about us, either in the stars, the nebulae or in the depths of space, the creative process is going on, and that the cosmic rays which have been studied for the past few years constitute the announcements broadcast through the heavens of the birth of the ordinary elements out of positive and negative electrons.

When it is remembered that the positive electron is the nucleus of the hydrogen atom, and that the spectroscopic survey of the heavens shows the extraordinary abundance everywhere of hydrogen; and when we reflect that we have known for fifteen years that all the elements have weights that are practically exact multiples of the weight of the hydrogen atom as it appears in the structure of helium, the foregoing conclusion that the process of atom-building out of positive and negative electrons (the latter have a mass that is negligible in comparison with the former) is now going on gains additional plausibility.

If it is confirmed it will constitute new proof that this is a changing, dynamic and continuously evolving world instead of a static or a merely disintegrating one.

Further qualitative support for the validity of the foregoing evidence is derived from the fact that so far as we can now see there are no sorts of nuclear changes which could take place powerful enough to produce the observed cosmic rays except those herewith suggested.

Putting together, then, the quantitative and the qualitative evidence, we may have some confidence in the conclusion that the heretofore mysterious cosmic rays, which unceasingly shoot through space in all directions, are the announcements sent out through the ether of the birth of the elements.

R. A. MILLIKAN,  
G. H. CAMERON

#### FORMS AND PROPERTIES OF WATER SOLUBLE PHOSPHORUS IN SOILS

A RECENT publication from this laboratory gave a method for the quantitative determination of organic

and inorganic phosphorus in soil solutions and extracts. Another paper gave data showing the amounts of each form of phosphate in the displaced solutions and 1:5 water extracts and also presented results showing that the organic phosphate was not adsorbed by plants. Subsequent studies have given additional data on the forms and properties of the water soluble phosphorus in soils.

While studying the decolorization of soil solutions by the use of carbon black, it was noted that the carbon absorbed a considerable portion of the organic phosphate but very little of the inorganic phosphate. Further studies showed that while a considerable part of the organic phosphate was readily adsorbed by the carbon black, another portion was not easily removed by the use of carbon black. This is evident from the results of an experiment in which 100 cc. portions of two soil extracts were treated with 0.20, 0.50, and 2.00 gms. of carbon black. The results of the experiment are given in table 1.

TABLE 1

AMOUNTS OF INORGANIC AND ORGANIC PHOSPHATE IN SOIL EXTRACTS RECEIVING THE CARBON BLACK TREATMENTS INDICATED.

Treatment per 100 cc. extract	Extract 449		Extract 561	
	Inorganic PO <sub>4</sub>	Organic PO <sub>4</sub>	Inorganic PO <sub>4</sub>	Organic PO <sub>4</sub>
	p.p.m.	p.p.m.	p.p.m.	p.p.m.
None .....	0.58	0.38	Trace	0.24
0.20 gm. carbon..	0.61	0.23	Trace	0.12
0.50 gm. carbon..	0.61	0.23	Trace	0.12
2.00 gm. carbon..	0.51	0.21	Trace	0.12

The treatment with 0.20 grams resulted in the adsorption of 0.15 p.p.m. and 0.12 p.p.m. organic phosphate. Increasing the amount of carbon black to 2.0 gms. did not increase the amount of organic phosphate adsorbed. Similar results have been secured with extracts of other soils and with some displaced soil solutions.

In another experiment two soil extracts and a soil solution were treated one, two and three times with 0.50 gms. of carbon black. In all cases the first treatment resulted in the adsorption of considerable organic phosphate while the second and third treatments removed very little additional phosphate.

These results seem to indicate the presence of at least two forms of organic phosphate in soil extracts and solutions. One form is very readily adsorbed by carbon black while the other form is adsorbed in small amounts if at all. The relative amounts of the two forms seem to vary somewhat in the extracts and solutions from different soils. In general, however, they are usually present in approximately equal amounts. Neither form seems to be associated with the coloring

matter of the extract or solution as many extracts that are practically colorless contain considerable amounts of both forms.

All the organic phosphate is apparently rather stable toward heat. Soil extracts and a soil solution were boiled two hours under a reflux condenser without materially increasing their content of inorganic phosphate.

Experiments with aluminum hydrate, prepared by the method of Emerson, as a decolorizing reagent have shown that it removes all of the inorganic phosphorus from solution but does not adsorb all of the organic phosphate. It does, however, adsorb some organic phosphate, probably the same portion that is readily adsorbed by carbon black. Increasing the amount of aluminum hydrate ten times did not increase the adsorption of organic phosphate.

These results confirm those previously reported showing that soil solutions and extracts contain considerable quantities of organic phosphate as well as inorganic phosphate. They further indicate that there are at least two forms of organic phosphate. Additional studies should be made to determine other properties of the organic phosphate including its rate of decomposition by biological action.

F. W. PARKER

SOILS LABORATORY,  
ALABAMA AGRICULTURAL EXPERIMENT STATION

## THE AMERICAN PHILOSOPHICAL SOCIETY

THE annual general meeting of the American Philosophical Society will take place in Philadelphia on April 19, 20 and 21. Following is the preliminary program of the sessions for the reading of scientific papers:

Thursday, April 19, at 2:00 P. M.

Francis X. Dercum, president, in the chair

*Tundra vegetation of Central Alaska:* JOHN W. HARSHBERGER, professor of botany, University of Pennsylvania.

*Features of cells that live long:* DANIEL T. MACDOUGAL, director of the laboratory of plant physiology, Carnegie Institution of Washington.

*A geno-geographical study of the genus Bursa:* GEORGE H. SHULL, professor of botany and genetics, Princeton University.

*Trianaeopiper, a new genus of Piperaceae:* WILLIAM TRELEASE, professor of botany, University of Illinois.

*Cell division and differentiation:* EDWIN G. CONKLIN, professor of biology, Princeton University.

*Probable rôle of internal secretions in structure and growth as illustrated by breeds of dogs and peculiar types in man:* CHARLES R. STOCKARD, professor of anatomy, Cornell University.

*Functions of the internal secretions or endocrine organs that scientific progress has sanctioned:* CHARLES E. DE M. SAJOUS, professor of endocrinology, University of Pennsylvania, Graduate School of Medicine.

*Cod-liver oil and the cod:* ALFRED F. HESS, clinical professor of pediatrics, University and Bellevue Hospital Medical College, New York City. (Introduced by Dr. Dereum.)

*Different rates of growth among animals:* PHILIP P. CALVERT, professor of zoology, University of Pennsylvania.

*Friday, April 20, at 10 A. M.*

Henry Fairfield Osborn, vice-president, in the chair  
*Omorphamphus, a new flightless bird from the Eocene of Wyoming:* WILLIAM J. SINCLAIR, associate professor and curator, Princeton University.

*The reports of the Princeton University expeditions to Patagonia:* WILLIAM B. SCOTT, professor of geology, Princeton University.

*The astrapotheria of the Miocene of Patagonia:* WILLIAM B. SCOTT, professor of geology, Princeton University.

*Were the ancestors of man primitive brachiators?* WILLIAM K. GREGORY, professor of paleontology, Columbia University. (To be read by Francis Montague Ashley-Montagu.)

*Racial characters in human dentition:* MILO HELLMAN, New York City. (Introduced by Dr. Osborn.)

*Present status of the problem of human ancestry:* HENRY FAIRFIELD OSBORN, American Museum of Natural History.

*Flood control:* ARTHUR E. MORGAN, president of Antioch College. (Introduced by Dr. Conklin.)

*Storms which issue from the inland-ice of Greenland:* WILLIAM H. HOBBS, professor of geology, University of Michigan.

*A guide book to the world's weather and climates:* ROBERT DEC. WARD, professor of climatology, Harvard University.

*Friday afternoon at 2:00 P. M.*

Cyrus Adler in the chair

SYMPOSIUM ON AVIATION

*Commercial aspects of aviation:* WILLIAM P. MAC-CRACKEN, JR., assistant secretary of commerce for aeronautics.

*The application of aerodynamics:* EDWARD P. WARNER, assistant secretary of the Navy for aeronautics.

*Lighter than air machines:* C. E. ROSENDAHL, lieutenant commander, U. S. Navy.

*Heavier than air machines:* C. H. BIDDLECOMB, New York City (formerly major in the Royal Air Force).

*Meteorology for aviation:* WILLIAM R. BLAIR, major, Signal Corps, U. S. Army.

*Friday evening*

Reception from 8 to 11 o'clock in the Hall of the Historical Society of Pennsylvania.

RICHARD P. STRONG, professor of tropical medicine, Harvard University, will speak on "Studies of Human and Animal Diseases made during the Recent African Expedition."

*Saturday morning, April 21, at 10:00 A. M.*

William W. Campbell, vice-president, in the chair

*Can business be made a science?* EMORY R. JOHNSON, professor of transportation and commerce, University of Pennsylvania.

*Some economic implications in America's changing world status:* ERNEST M. PATTERSON, University of Pennsylvania. (Introduced by Dr. Johnson.)

*An enactment of fundamental constitutional law in old South Arabia:* JAMES A. MONTGOMERY, professor of Hebrew and Aramaic, University of Pennsylvania.

*Textual criticism of the Greek Old Testament:* MAX L. MARGOLIS, professor of biblical philology, Dropsie College for Hebrew and Cognate Learning.

*Research in education:* FRANK PIERREPONT GRAVER, president of the University of the State of New York.

*An early Colonel House: Unofficial missions to England in 1842 and 1843 of General Duff Green:* GEORGE LEAKIN SIOUSSAT, professor of American history, University of Pennsylvania. (Introduced by Dr. Liegelbach.)

*Fact:* HENRY OSBORN TAYLOR, New York City.

*Noah, a suggestion:* ROBERT P. FIELD, Philadelphia.

*Saturday afternoon at 2 P. M.*

Francis X. Dereum, president, in the chair

*Metabolism in the tropics: A study on some brown and blacks in Jamaica:* FRANCIS G. BENEDICT, director of Nutrition Laboratory, Carnegie Institution of Washington, and Morris Steggerda.

*Racial chromosomal differences in *Datura* and their bearing on differentiation of species:* ALBERT F. BLAKE-LEE, assistant director in plant genetics, Carnegie Station for Experimental Evolution, Cold Spring Harbor.

*Influence of groups containing sulphur on the color of azo dyes:* E. EMMET REID, professor of chemistry, Johns Hopkins University. (Introduced by Dr. Smith.)

*A method for determining the constants of electrical engineering, Harvard University:* ARTHUR E. KENNELLY, professor of electrical engineering, Harvard University.

*Discussion of the kinetic theory of gravitation IV: Correlation of continual generation of heat in some substances, and impairment of their gravitational acceleration:* CHARLES F. BRUSH, president of the Cleveland Chamber of Commerce.

*A search for the galactic center:* HARLOW SHAPLEY, director of the Harvard Observatory.

*The distances of the stars:* SAMUEL A. MITCHELL, professor of astronomy and director of the Leander McCormick Observatory, University of Virginia.

*Saturday evening, April 21, at 7:30 P. M.*

Annual dinner in the north room of the Bellevue-Stratford Hotel.

## FOR APRIL PUBLICATION

**Anthelmintics and their Uses** \$5.00

By ASA C. CHANDLER and R. N. CHOPRA. A concise and systematic study from the pharmacological and helminthological viewpoints for the physician, health worker, veterinarian, and pharmacologist.

To be published April 6

**Sir Isaac Newton: 1727-1927** \$5.00

Edited by FREDERICK E. BRASCH. A bi-centenary estimate of all phases of Newton's career, contributed to by leading scientists of America, among them: David Eugene Smith, Michael I. Pupin, Paul W. Heyl, Florian Cajori and George E. Roberts. Published in conjunction with The History of Science Society.

To be published April 10

**Filterable Viruses** \$7.50

Edited by THOMAS M. RIVERS. A summary of existing knowledge of the filterable viruses, presenting ten discussions from the pens of as many leading investigators. Contributions by T. M. Rivers, Stuart Mudd, Alexis Carrel, E. V. Cowdry, Harold L. Amoss, P. K. Olitsky, E. W. Goodpasture, R. W. Glaser, L. O. Kunkel and J. Bronfenbrenner.

To be published April 23

**Leaf-Mining Insects** \$6.00

By JAMES G. NEEDHAM, S. W. FROST and B. H. TOTHILL. An introduction to the study of leaf-mining insects, an account of their natural history, and lists of leaf-miners and their food plants.

To be published April 26

**Physiology and Biochemistry of Bacteria** \$7.50

By R. E. BUCHANAN and ELLIS I. FULMER. An introduction to the growth phases, composition, and biophysical chemistry of bacteria and their environment, and energetics.

To be published April 28

**The Williams & Wilkins Company**

Publishers of Scientific Books and Periodicals  
Baltimore, Maryland

## JUST PUBLISHED

**GUIDE TO THE STUDY OF FRESH-WATER BIOLOGY.** With extensive illustrations, keys and tables. \$1.00

By

JAMES G. NEEDHAM—Professor of Limnology and Entomology, Cornell University.  
(Co-author, Paul R. Needham)

**NEEDHAM—GENERAL BIOLOGY.** A book of outlines and practical studies for the general student. Copiously illustrated. 13th edition. \$2.50

**NEEDHAM — THE LIFE OF INLAND WATERS.** An elementary text-book of Fresh-Water biology. \$3.00  
(Co-author, John T. Loyd, Ph.D.)

**NEEDHAM—THE NATURAL HISTORY OF THE FARM.** An analysis of the sources of agriculture. Fully illustrated.

**THE AMERICAN VIEWPOINT SOCIETY, INC.**  
15 Astor Place New York City

## Marine Biological Laboratory Woods Hole, Mass.

### INVESTIGATION

Entire Year

Facilities for research in Zoology, Embryology, Physiology, and Botany. Fifty-two private laboratories \$100 each and ninety-four private laboratories \$200 each for not over three months. Fifty-six tables are available for beginners in research who desire to work under the direction of members of the staff. The fee for such a table is \$50.00.

### INSTRUCTION

June 27 to August 7, 1928

Courses of laboratory instruction with lectures are offered in Invertebrate Zoology, Protozoology, Embryology, Physiology, and Morphology and Taxonomy of the algae. Each course requires the full time of the student. Fee, \$75.00.

The annual announcement will be sent on application to The Director, Marine Biological Laboratory, Woods Hole, Mass.

### SUPPLY DEPARTMENT

Open the Entire Year

### Biological Supplies

For the classroom, museum or collector.

Look for the sign of the Limulus. As the Limulus represents the test of time, we feel from the business growth that our supplies have also stood the test of years.

Send for Catalogue

No. I. Zoological and Embryological material. Life Histories and Habitat Groups.

No. II. Botanical material.

No. III. Microscopic Slides.

Address all correspondence regarding material and catalogues to:

Supply Department

GEO. M. GRAY,

Curator, Woods Hole, Mass.



## SCIENCE NEWS

*Science Service, Washington, D. C.*

## COPPER AS AN ANEMIA PREVENTIVE

COPPER, the red metal, is an essential factor in the diet to keep the blood red and the body vigorous, a group of University of Wisconsin chemists headed by Dr. E. B. Hart, announced recently at the meeting of the American Society of Biological Chemists.

Copper may become acknowledged as one of the more essential requisites in human nutrition and livestock feeding. The Wisconsin experiments indicate that it exerts a tremendous influence on anemia in rats, a disease similar to anemia in children who have been fed exclusively on milk. The malady in both rat and child is caused by a deficiency of hemoglobin in the blood stream.

A shortage of iron has been credited with being responsible for the disorder, and, although iron compounds are still limiting factors, their effectiveness, according to Wisconsin investigators, depends on the presence or absence of copper. The investigations covered four years, and Dr. Hart was assisted by his colleagues, Drs. H. Steenbock, C. A. Elvehjem and J. Waddell.

Because milk is notoriously low in iron and hemoglobin is rich in the mineral, it has always been assumed that the way to correct anemia was to add iron to the milk diet.

In the case of animals this plan proved ineffective. The daily feeding of iron, administered as chloride, sulfate, acetate, citrate or phosphate, all prepared from pure iron wire, did not check the decline in the hemoglobin content of the blood. Rats suffering with anemia were not improved.

However, when a supply of iron was obtained by feeding dried liver, or the ash of dried liver, corn or lettuce, the hemoglobin was raised to normal and the stricken rats immediately restored to health. In ashing the food-stuffs, the investigators noted a pale, bluish color, the typical hue produced when copper compounds are burned. Observation of this peculiar color, in addition to the fact that copper is known to be present in the respiratory pigment, hemocyanin, of certain crustacea, led the chemists to use copper sulfate as a supplement to pure ferric chloride in the whole milk diet.

Striking cures resulted. Rats, so anemic that their days appeared to be numbered, recovered immediately and the hemoglobin in their blood was brought to normal.

"What about pernicious anemia in man?" the chemists asked. Patients suffering with anemia have been told to eat liver, advice which has evidently made a wide impression, judging from the rise in price of what was once poor man's meat. However, some sufferers find liver unpalatable, especially when eaten in large quantities. Harvard University scientists have prepared a liver extract which has proved exceedingly efficacious in abating the disease. In the Wisconsin experiments, this product was ashed and fed the anemic rats. When fortified with ferric chloride, it also proved effective in correcting the ailment. Thus this product which has been most successful in treating man corrected the deficiency in rats.

Copper's rôle in plant and animal tissue is not clearly understood. It is found in milk, in small quantities. Its function in producing hemoglobin is, as Hart states, unknown. Hemoglobin may not contain copper, at least no evidence to the contrary has yet been produced. In this connection, copper may act as a catalyzer, an agent which starts an action without being changed itself. It may promote the building of hemoglobin. Iron functions in a similar manner in the production of chlorophyll, the green pigment of vegetation, although it is not a constituent of the chlorophyll molecule.

Experiments with the use of copper in the diets of anemia patients will be undertaken in the near future at certain leading hospitals. If this inorganic substance plays the part in the human system that it does in the life of white rats, nutrition specialists will probably give as much consideration to the copper content of food-stuffs as is now paid to some other elements, such as phosphorus, calcium and iodine. Future experiments at Wisconsin will also approach the problem from this standpoint, as the copper content of animal feeds is known to vary widely.

## THE BORAX INDUSTRY

EXPLOITATION of the kernite (also called rasorite) deposits in the Mohave Desert, Kern County, California, probably will result in killing off the mining of other borate minerals elsewhere in this country and in other countries so that the United States will have a complete monopoly, according to Dr. Waldemar T. Schaller, of the U. S. Geological Survey.

So far as is known, kernite, an entirely new mineral, exists nowhere else in the world. The deposit lies but three to four hundred feet beneath the surface, is more than 100 feet thick and extends at least 500 feet in every direction. It was discovered in 1926 and mining operations were begun approximately a year ago.

Kernite is virtually pure sodium borate. The material mined is over 75 per cent. pure mineral, the remainder being clay. To prepare it for the market it is only necessary to dissolve it in water, filter off the clay, and permit recrystallization to take place. Marketable borax is sodium borate plus ten molecules of water. Kernite is the same sodium borate plus four molecules of water. During the refining process six molecules of water are added so that one ton of kernite makes 1.4 ton or nearly a ton and a half of borax. There is probably no other commercial mineral that increases its marketable bulk in such a fashion through the process of refining.

Previous to the discovery of kernite the world's borax supply was derived principally from the minerals borax, colemanite and ulexite. Italy procured it from volcanic steam containing boric acid. In each case the process involved was complex and expensive. In this country borax was formerly secured from mineral deposits in and near Death Valley, under dangerous circumstances, and

## School of Medicine and Dentistry THE UNIVERSITY OF ROCHESTER

Medical School, Strong Memorial Hospital, School of Nursing and Out-Patient Department of the University of Rochester and the Municipal Hospital of the City of Rochester, all under one roof. Medical, Surgical, Obstetric, Pediatric, Contagious and Neurological patients admitted. Unusual opportunities for school and hospital cooperation in medical and dental teaching.

### Admission

Medical and dental candidates must have completed three years of college work with special requirements in chemistry, physics and biology. The entering class will not exceed 40, men and women being admitted on equal terms.

### Tuition

Charge for tuition will be \$300 per annum, payable in equal installments at the beginning of each semester.

*For information address*

**THE DEAN**

School of Medicine and Dentistry  
Crittenden Station, Rochester, N. Y.

## JOHNS HOPKINS UNIVERSITY SCHOOL OF MEDICINE

The School of Medicine is an Integral Part of the University and is in the Closest Affiliation with the Johns Hopkins Hospital.

### ADMISSION

Candidates for admission must be graduates of approved colleges or scientific schools with two years' instruction, including laboratory work, in chemistry, and one year each in physics and biology, together with evidence of a reading knowledge of French and German.

Each class is limited to a maximum of 75 students, men and women being admitted on the same terms. Applications may be sent any time during the academic year but not later than June 15th.

If vacancies occur, students from other institutions desiring advanced standing may be admitted to the second or third year provided they fulfill the requirements and present exceptional qualifications.

### INSTRUCTION

The academic year begins the Tuesday nearest October 1, and closes the second Tuesday in June. The course of instruction occupies four years and especial emphasis is laid upon practical work in the laboratories, in the wards of the Hospital and in the dispensary.

### TUITION

The charge for tuition is \$400 per annum, payable in two installments. There are no extra fees except for certain expensive supplies, and laboratory breakage.

Inquiries should be addressed to the Executive Secretary of the School of Medicine, Johns Hopkins University, Washington and Monument Sts., Baltimore, Md.

Graduates in Medicine who satisfy the requirements of the heads of the departments in which they desire to work are accepted as students for a period not less than three quarters. Tuition charge is \$50 a quarter.

## BOSTON UNIVERSITY SCHOOL OF MEDICINE

ORGANIZED IN 1873

### ANNOUNCEMENT

may be obtained by application to

**THE REGISTRAR**

80 East Concord Street

Boston

Massachusetts

## School of Medicine Western Reserve University

Cleveland, Ohio

**NEW LABORATORIES AND  
HOSPITALS**

**RESTRICTED CLASSES**

**THOROUGH INSTRUCTION**

**LARGE CLINICAL FACILITIES**

**HIGH STANDARD OF SCHOLAR-  
SHIP**

Admission confined to students having academic degrees and to Seniors in Absentia.

*For information address:*

**THE REGISTRAR**

2109 Adelbert Rd.

CLEVELAND

had to be hauled from the mines by the familiar "twenty-mule team," to a distant railroad.

The kernite mines are within four miles of the Santa Fé main line and a spur track, built at small expense across the intervening alluvial flat, has made transportation simple. It is estimated that enough of the mineral already has been blocked out to supply the market for some time and millions of tons for future needs require only to be shoveled out of the ground, dissolved in water, and recrystallized.

### CAMOUFLAGED TRAPS

CAMOUFLAGE patterns are now used for mouse traps. At the office of the United States Biological Survey in Washington, clever devices, designed to catch the most wary of mice, are on exhibit.

For the field mouse who robs the corn crib there is a trap made by hollowing out the center of a corn cob and wiring it. The mouse who boldly chews the papers on your desk makes his last predatory excursion the night he examines what appears to be an ordinary steel wire paper-clasp.

One clever trap will reset itself and capture as many as six or eight mice in an evening. When the mouse enters, the small metal door falls shut. Seeking a way out, he ascends a miniature passageway which leads to a plunge in a half-gallon can of water. The trap is so constructed that it automatically resets itself when the victim plunges into the water.

Still another trap, one that any boy could make, is fashioned out of an ordinary tin can. The top has been carefully cut all the way around, rewired in place and equipped with a simple spring. When set, it appears to be nothing more harmful than the usual tin can whose top has been incompletely mashed in. But when the mouse investigates he finds that the top springs into place with surprising quickness, leaving him locked inside.

These traps, and many others designed for larger and more dangerous prey, such as mountain lions and wolves, have been collected by the survey during its long campaign to eradicate predatory animals. Economic experts of the bureau estimate that rodents alone, such as mice, rats, prairie-dogs, ground-squirrels and jack-rabbits, are responsible for a crop-production loss of approximately \$500,000,000 each year. In addition some of them, such as rabbits and rats, have been found to be carriers of disease and therefore dangerous from the standpoint of public health.

### LOSS IN INDUSTRY FROM COLDS

COLDS and their relatives, such as pneumonia, influenza and bronchitis, are responsible for more lost time in industry than any other group of diseases.

Statisticians of the U. S. Public Health Service have found that over half, 54 per cent. to be exact, of the illnesses of the men employed by a large industrial firm throughout a period of ten years were caused by colds and other respiratory infections. Furthermore, the reports of a group of sick-benefit associations show that

47 per cent. of the illnesses lasting eight days or longer among male members were due to the same causes.

"From the effect upon the absence rate in industry no other disease group," declared Dean K. Brundage, assistant statistician in the Public Health Service, "approached in importance the respiratory diseases. Among employees of the industrial firm described above, diseases of the respiratory system caused more absences from work than all other diseases put together. The sickness records of the company revealed an annual loss of 3.22 calendar days of disability from respiratory diseases per male employee, compared with 6.92 calendar days of disability from all causes of sickness per man on the pay roll."

"In view of the frequency of disability and the amount of time lost from work on account of the respiratory diseases even a small degree of success in their prevention would contribute enormously to the sum total of physical and mental energy, to the number of days that the industrial population is physically able to work and, accordingly, to an enhanced national prosperity."

Careful scientific analysis of records, it is believed, will cast some light on the causes of these two prevalent infections. One of them, lobar pneumonia, is being subjected at the present time to special investigation by the Public Health Service in an attempt to evaluate the more important factors influencing its incidence and high death rate.

### THE TARANTULA

THE common tarantula of the southwest achieves a ripe old age and can easily go without food for periods as long as a month or six weeks.

Professor W. J. Baerg, of the University of Arkansas, well-known authority on spiders, has kept tarantulas in his laboratory under observation for nine years, until the life cycle of this member of the spider family, not previously known to science, is now fairly clear.

The male tarantula is approximately eleven years old before he attains maturity, declared Professor Baerg in a report to appear in a forthcoming issue of the *Quarterly Review of Biology*. Since a tarantula only locates his food by touch and sits serenely at the door of his burrow in the earth, waiting for his dinner to walk by in front of him, he is equipped to withstand long periods of starvation. Consequently the period at which the spider attains all the attributes of adulthood is probably determined in a measure by the amount of fasting his lethargic habits have caused him to endure. The same statement probably holds good for the female as well.

"They locate their prey entirely by sense of touch," Professor Baerg explained. "Thus a cricket may come within a centimeter of where the tarantula is waiting, and be perfectly safe; however, as soon as one touches the other, the cricket is very speedily brought in reach of the fangs and consumed." Grasshoppers, cockroaches and caterpillars vary the spider menu in the laboratory, but if they are kept in a cold room they will not require any food from early in October until late in March.

## Carnegie Institution of Washington

Barnard, E. E. Atlas of Selected Regions of the Milky Way. Edited by Edwin B. Frost, assisted by Mary R. Calvert. Publication No. 247, in two parts ..... \$10.00

Part I. Photographs and Descriptions. vii + 126 pp.

Part II. Charts and Tables. viii + 202 pp.

Part I contains 51 photographic prints of regions of the Milky Way selected by the late Professor Barnard from a large number of photographs taken by him with the Bruce telescope at Yerkes Observatory and at the Mount Wilson Observatory of the Carnegie Institution of Washington. The prints are 10 inches square and faithfully reproduce the varied details shown in the negatives. As the edition of this volume was 700 copies, there were made 35,700 photographic prints.

Facing each print is a page of descriptive matter giving the results of the author's minute studies of its features based upon many years of observation. An introduction describes Professor Barnard's telescope and the methods of observation and reproduction which he employed. The author's views on the nature of the Milky Way are quoted. The Atlas also contains a list of "dark objects" in the Milky Way discovered by him and a frontispiece in photogravure of Professor Barnard.

Part II contains 51 key charts corresponding to the photographs in Part I, each to each. The user of the *Atlas* wishing to make a careful study of a particular photograph opens both volumes at corresponding pages. The key chart enables him to identify all of the principal objects in the photograph. It also contains much information in compressed form about the region covered by it.

Correspondents may obtain price-lists or classified lists, as issued, by furnishing requisite addresses. Books may be ordered through your book-dealer or requests may be sent direct to

**CARNEGIE INSTITUTION OF WASHINGTON**  
Washington, D. O., U. S. A.

## GENERAL CHEMISTRY

By LEON B. RICHARDSON

*Professor of Chemistry in Dartmouth College*

Designed as a text in General Inorganic Chemistry, this book contains much material of an illustrative and explanatory character which is usually confined to class lectures. Those points which the student is likely to find troublesome or difficult of comprehension have been clarified by means of homely examples and detailed descriptions, and the discussion as a whole has been made highly attractive by virtue of an abundance of concrete illustrations and a vivid style.

There has been no straining to secure novelty, either in order or method, where present practice has seemed satisfactory. The subject matter has been developed from the start, and the book is well adapted to college courses taken by students with or without previous chemical instruction. Moreover, the abundance of material permits the individual teachers the choice of advantageous selection.

Teachers who have used *General Chemistry* this year have written to tell us that they found the book a highly teachable text. \$3.75.

## A LABORATORY MANUAL OF GENERAL CHEMISTRY

By LEON B. RICHARDSON & A. J. SCARLETT, JR.

*Dartmouth College*

This manual is written to accompany Richardson's *General Chemistry*. The 54 selected experiments range over the entire field of general chemistry, and all of them will accomplish the desired purpose without being too involved. Like the text, the manual can be used for students who have had no previous work in chemistry. Ready this spring.

**HENRY HOLT AND COMPANY**  
One Park Avenue New York

For many years scientists were puzzled because, in spite of diligent search, no males were seen out-of-doors in the field except at the mating season in September and October. Professor Baerg's hand-raised tarantulas, however, have furnished the answer. During the eleven years it takes the male to grow up, he changes his skin 22 times, and only after the last is distinguishable from the female. Soon after the mating season the males decline and die, rarely surviving to see another season.

The females, on the other hand, present a very different picture. After attaining sexual maturity at 12 or 13 years of age they continue to live on till they are at least 20 and probably much older.

Professor Baerg's observations, he pointed out, have not been made on one individual tarantula from hatching time until death, but on several of various ages that have been under observation at different stages of development.

### PLANT ROOTS

WHEN you pull up a radish from your spring garden you are gathering in materials that were once scattered around through the soil to distances of more than a foot on either side of the little pungent globe in your hand, or buried two feet or so underneath it. Later on, when you gather your first ears of sweet corn, you will be getting the benefit of work done by roots through a circle five feet in diameter and three or four feet deep. Roots are the world's greatest miners.

The wide-spread activities of the roots of garden vegetables, hitherto suspected but never intensively examined, have been the subject of research by Professor John E. Weaver and Dr. William E. Bruner, of the University of Nebraska. Their work has involved much hard digging in the literal as well as the figurative sense, for a five-foot trench had to be excavated alongside of each plant studied, and the details of the roots' travels followed with hand tools.

Annual vegetable crops like radishes, beans, melons and turnips will occupy in their few weeks of growth a great deal more space in the soil than their tops occupy in the air, and their roots will drill a great deal deeper than their stalks go high. Longer-lived plants, such as rhubarb and asparagus, do not send their roots a great deal deeper, but tend to solidify their holdings, by penetrating the soil much more thoroughly with their bushier branching systems. A four-year-old rhubarb plant, for example, was found to occupy a cylinder of soil eight feet in diameter and eight feet deep, with some of the longer roots straggling downward an additional two or three feet. A ten-year-old plant of horseradish reached out only eighteen inches or so on either side of its crown, but its roots drilled downward to a depth of more than fourteen feet.

### CALIFORNIA TREES

YELLOW pine trees from all over the United States are being tested and cross-pollinated at the Eddy Tree Breeding Station, at Placerville, Calif., in an effort to obtain choice varieties of forest trees that will grow faster than the present wild stocks and hence produce a crop of tim-

ber in fewer years. Nursery plantings made last season include seedlings of 49 species and 9 varieties, from seeds obtained in 17 different countries; and extensive additions are now in hand as part of this season's program.

The program of the station includes gathering tree stocks from as many different localities as possible, comparing geographic races of the same species, selection of the best individuals in native stands as breeding stocks, and artificial pollination both within given species and between species in an effort to produce hybrid varieties. Cross-pollination thus far has yielded hybrids of Western yellow pine with Swiss mountain pine and with the digger pine of California.

The second tree genus on which the experimenters intend to work is the black walnut. They now have a stock of the black walnut species of northern California established, but have not yet reached out for the Eastern and Old World walnuts, due to their preoccupation with the pine work. Eventually they wish to add other timber trees to the two now on their experimental schedule.

The work of the station is under the direction of Lloyd Austin, a graduate of the University of California.

### ITEMS

COLLECTORS of old china will be interested to know that the authenticity of certain types of old porcelain can now be determined by chemical tests. Under the direction of Dr. Alexander Scott tests have been worked out in the laboratory of the British Museum that have helped classify several doubtful pieces in the museum collections without disfiguring the specimens. Old patent acts were consulted to determine the chemical composition of Old Bow and Chelsea china, while tests were then resorted to to detect the presence of various phosphate components known to have been used in its composition.

THE people of the United States are to be the beneficiaries of a patent obtained by E. N. Bates, of the U. S. Department of Agriculture, on a seed-cleaning machine operating on an entirely new principle, which the inventor calls an "aspirator." The device consists essentially of a funnel-shaped hopper into which the grain, seeds or other material is poured. From this it is allowed to fall in a thin circular stream into a chamber beneath, flowing over a wide, cone-shaped valve. As the grain trickles down, a current of air is sucked upward through it by a motor-driven fan. In this air current all dust, light seeds, bits of straw and chaff and, in general, all particles lighter than the seeds being cleaned are carried off into a side chamber, where they are deflected into a receiving cup. The cleaned grain meanwhile falls into a receiving pan on its own side. Mr. Bates has constructed two different types of his aspirator, one for large-scale use on a threshing separator and the other for laboratory use in seed-testing and similar work. The machine is covered by Public Patent No. 1524012. Under the terms of American patent law, any article so patented may be manufactured and used in the United States by any citizen without the payment of royalty.